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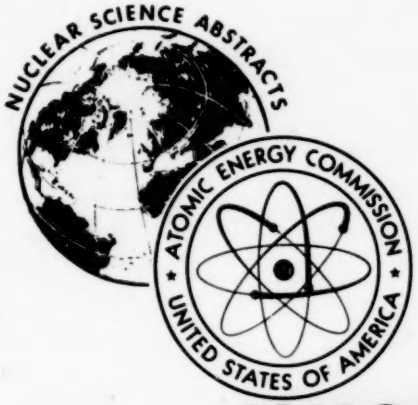

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Volume 18, Number 3, February 15, 1964

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Volume 18, Number 3 February 15, 1964

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

3437 (CEA-Bib-31) LES RADIOÉLÉMENTS EN PARASITOLOGIE HUMAINE (1963). (Bibliography on Radioelements in Human Parasitology (1963)). L. Roule (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 59p.

Parasite research in which radioisotopes were used was reviewed, and a bibliography was prepared. One index is included that lists the isotopes and their uses; another index lists the parasites and the isotopes used with them. (H.M.G.)

3438 (LF-11) PROCEDURES AND EQUIPMENT IN INHALATION STUDIES ON SMALL ANIMALS. Technical Progress Report. R. G. Thomas and R. Lie (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Sept. 1963. Contract AT(29-2)-1013. 30p.

Procedures and equipment used in exposing small animals to aerosols of fission products are described. The exposure chamber with attached plethysmographs for monitoring the respiratory patterns is shown diagrammatically and the operational plan is set forth. Construction criteria for the plethysmographs are also included in detail. The descriptions concerning the animals include specifications on metabolism units and cleaning procedures, whole body counting and somewhat detailed sacrifice and necrotomy procedures. (auth)

3439 (WP/31/2) INFORMATION CIRCULAR ON RADIATION TECHNIQUES AND THEIR APPLICATION TO INSECT PESTS. (International Atomic Energy Agency, Vienna). July 1963. 30p.

Summaries are presented of 46 papers covering various aspects of applications of radioisotopes in studies of insect pests of interest in agriculture. Emphasis is placed on the use of labeled insects and their parasites in studies of the migration, population density, and metabolism of insect pests. The effect of radiation on insects during various developmental stages, radioinduced mutations in insects, and the release of irradiated males as a means of control are also discussed. (C.H.)

3440 (JPRS-22186) LABELING FLIES AND MOSQUITOES WITH RADIOACTIVE PHOSPHORUS. N. V. Il'yinskaya and A. S. Troshin. Translated from Zool. Zh., 33: 841-7(1954). 10p. (OTS-63-41316)

A method is described for the large scale labeling of flies and mosquitoes with P^{32}. Methods of collecting, isolating, and keeping insects in the laboratory and the use of labeled insects in ecological studies are discussed. (C.H.)

3441 THE EFFECT OF HEAVY WATER ON THE PROPERTIES OF DNA AND OF PROTEINS. V. V. Grechko, R. N. Maslova, L. S. Shkarenkova, E. I. Silina, and Ya. M. Varshavskii (Inst. of Radiation and Physical-Chemical Biology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 740-3(Sept. 21, 1963). (In Russian)

The viscosity and absorption in the ultraviolet region of the spectrum at 259 mμ were used as tests to follow the thermal and acid-base denaturation of DNA in H_2O and in D_2O. Structural transitions in the DNA molecules were observed at critical values of pH or pD. Thus, 50% denaturation of DNA was observed at a pH of 2.65 and a pD of 3.05 from the absorption of light at 259 mμ, and at a pH of 2.75 and a pD of 3.15 from the change in viscosity. The difference pD-pH is 0.40 units on the acid side. Approximately the same difference is observed when denaturation is carried out on the alkaline side at a pH of 11.30 and a pD of 11.70. Hence, the change in the physical-chemical properties of DNA solutions in going from a H_2O solution to a D_2O solution can be explained primarily by a change in the dissociation constants of the functional groups of the DNA nucleotides. It was also found that the dissolution of the complex formed by an antigen with an antibody in an excess of antigen is strongly decreased in the presence of D_2O as compared to H_2O. (TTT)

3442 CLINICAL AND EXPERIMENTAL STUDIES WITH I-125: THE USES OF Na ^{125}I, ^{125}I-ROSE BENGAL AND ^{125}I-HIPPURAN TO INCREASE THE RESOLUTION OF SCINTIGRAM AND MICRO-AUTORADIOGRAPHY. Teruo Nagai (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 12: 100(May 1963). (In Japanese)

Clinical and experimental studies using I^{125} are compared with I^{131}. The counting rate profiles across box phantoms containing wax plugs representing the cold nodules were obtained using two-centimeter slit collimators. A wax plug on the phantom surface produced a smaller reduction in counting rate for I^{125} than for I^{131}. The smallest detectable cold nodules in thyroid and liver phantoms were estimated. For the thyroid phantom a cold nodule under 5 mm in diameter was detectable with I^{125}, while a 1.5 cm diameter was required with I^{131}. For the liver phantom a cold nodule on the surface which was invisible using I^{131} was detected using I^{125}. In clinical studies 11 cases of thyroid scans, 18 cases of I^{125} rose bengal liver scans, and one of I^{125} hippuran renal scan were made and compared with I^{131} thyroid and liver scans and Hg^{203} neohydrin renal scan. In all cases a marked increase in contrast was shown with I^{125}. Very high resolution, comparable to H^3, was obtained in micro-autoradiography of rabbit's thyroid glands, livers, and kid-

neys using sodium I^{125}, I^{125} rose bengal, and I^{125} hippuran. From these results the advantages in substituting I^{125} for I^{131} in nuclear medicine were discussed. (auth)

3443 CONTRIBUTION OF MEASUREMENT METHODOLOGY TO THE ACCUMULATION OF I^{131} IN THE THYROID. H. Luethy (Buergerspital, Basel). Schweiz. Med. Wochschr., 93: 875-8(June 15, 1963). (In German)

The effects of measurement distance, field size, collimator shielding, scattered radiation, and use of filters were studied by means of a phantom with two types of commercial NaI probes. The optimum measurement distance varies with the probe used because of the differences in scattered radiation from the crystal casings and collimator shielding. Source-crystal distances should be measured from the crystal face. The field size, defined as the distance over which the count from a point source amounts to 90% or more of the value at the central axis, was 9 and 11 cm at distances of 30 and 40 cm, respectively. The optimal thickness of lead filters ranges from 0.8 to 2 mm. Uncertainty as to the true depth of I^{131} thyroidal deposition probably does not introduce more than a 5% measurement error. Correction for extra-thyroidal I^{131} activity by thigh measurements is important for early periods after administration. Measurements on five patients showed that the nonthyroidal neck activity was from 1.2 to 1.7 times that of the thigh. Corrections for body background are more reproducible when a 2.5-mm lead shield is placed directly on the collimator opening instead of over the thyroid region. (BBB)

3444 UKAZATEL' LITERATURY PO PRIMENENIYU RADIOAKTIVNYKH I STABIL'NYKH IZOTOPOV V BIOLOGII ZA 1950-1958. (Bibliographies on Applications of Radioactive and Stable Isotopes in Biology for 1950 to 1958). Moscow, Publishing House of the Academy of Sciences, 1962. 408p.

Bibliographies are given to domestic and foreign literature on radioactive and stable published during 1950 to 1958, on radioactive and stable isotopes in biology. (R.V.J.)

3445 STUDIES OF COMPLETELY DEUTERATED PROTEINS. II. THERMAL DENATURATION IN D_2O. Donald S. Berns (N. Y. State Dept. of Health, Albany and Union Univ., Albany, N. Y.). 16p. (CONF-117-28)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Thermal denaturation studies of a fully deuterated protein and its hydrogen analogue (algae chromoprotein phycocyanin) in buffered D_2O demonstrate that the deuterio protein always denatures at a lower temperature than its hydrogen analogue. Cross comparisons of thermal denaturation in D_2O and H_2O do not give a simple picture which is easily interpreted. All results are, however, consistent with the suggestion that internal rotation is an important factor in the determination of protein structure. (auth)

Ecology

3446 (NAS-NRC-Pub-1092) THE BEHAVIOR OF RADIOACTIVE FALLOUT IN SOILS AND PLANTS. A Review Prepared for the Committee on Effects of Atomic Radiation on Agriculture and Food Supplies. M. H. Frere, R. G. Menzel (Department of Agriculture. Soils Lab., Beltsville, Md.); K. H. Larson (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology); Roy Overstreet (California. Univ., Berkeley); and R. F. Reitemeier (Division of Biology and Medicine, AEC). 1963. 36p.

The sequence of events involved in the transfer of radioisotopes from fallout to the tissues of man through the food chain are reviewed. Topics discussed include the reactions of radioisotopes with soil; the uptake, translocation, and distribution of radioisotopes in plants; external and internal effects of radiation on plants; soil-plant relations; and the effect of soil management on the uptake of radioisotopes by plants. Emphasis is placed on the path of Cs^{137} and Sr^{90} through the food chain. (142 references.) (C.H.)

3447 (NYO-10581) A STUDY OF STRONTIUM, BARIUM, AND CALCIUM RELATIONSHIPS IN SOILS AND VEGETATION. Final Report. J. F. Gamble (Rutgers Univ., New Brunswick, N. J. Coll. of Agriculture). 1963. Contract AT(30-1)-2494. 80p.

Strontium, Ba, and Ca relations in soils and vegetation were studied at three locations in New Jersey. A spectrochemical procedure was developed for direct powder analysis of soils using a d-c arc excitation in an $Ar-O_2$ atmosphere. Foliar analysis was by the $NaNO_3$ buffer method, and certain trace elements were determined by a concentration procedure. A statistical analysis, element by element basis, was made of the A and B horizon of the respective soils. The elements compared were: Sr, Ba, Ca, K, Mg, Mn, Al, Si, Fe, Cu, and Ti. Statistical comparisons, element by element basis, were made of the foliar analysis for Sr, Ba, Ca, K, Mg, Mn, Al, and Cu. Cadmium, Zn, Pb, Cr, Ga, Sn, V, Co, Ni, and Ti were also determined for most species. Soils were fractionated according to size, the separates were identified, and a composition analysis was made on the separates as well as the total soil. Analyses included organic matter, pH, mechanical analysis, separation and identification of the heavy and light minerals, clay size minerals, and the soil extracts. Element comparisons of the foliar analyses showed a high degree of species specificity. Distribution of Sr, Ba, and Ca, in the soils studied, was only slightly influenced by pedogenic factors. No strong geochemical distribution relation was noted between Sr, Ba, and Ca. The Ca : Ba ratio and Ba : Sr ratio were more closely related among the three soils than the Ca : Sr ratio. The data indicate that sampling from three sites within a location is adequate for statistical comparisons of soil and foliar analysis. (auth)

3448 EXPERIMENTAL STUDY OF RADIOACTIVE CONTAMINATION BY CERIUM-144 OF A COMPLEX FRESH-WATER COMMUNITY STUDIED IN THE LABORATORY. Y. A. Fontaine and A. Aeberhardt (CEA, Saclay, France and Muséum d'Histoire Naturelle, Paris). Health Phys., 9: 1047-56(Nov. 1963). (In French)

The experimental laboratory study on cerium-144 contamination of a complex fresh-water community extending over a period of 41 days is described. The kinetics of contamination and its extent have been ascertained comparatively on the separate members of the community. The cerium-144 is rapidly extracted from the water by fixation on all solids and living organisms, particularly on green algae and water fleas (Daphnia). The internal contamination of fish and molluscs is very slight, but these animals are exposed to intense irradiation, due to the presence of cerium-144 in their digestive tracts. Eighteen days after introduction of the radioelement, the concentration of cerium-144 in the above algae, water fleas, mollusc viscera, and contents of the digestive tracts of the fish varied between 20 and 300 times the initial radioactivity (per g) of the water. The viscera of the molluscs undergo irradiation estimated at 215 rad/day, for an initial contamination of the water of 0.02 μC/g. (auth)

3449 BEHAVIOR OF FALLOUT RADIOCONTAMINANTS IN THE FOOD CHAIN. C. L. Comar and J. C.

Thompson, Jr. (Cornell Univ., Ithaca, N. Y.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 9-22(1963).

Basic aspects of the physical and biological properties of certain radionuclides, particularly in regard to the factors that influence the potential hazard as environmental contaminants, are given. The parameters of importance are: physical properties of the nuclide, especially the half-life and solubility; metabolic behavior, especially the efficiency of transfer through the food chain and retention in the individual, and food technology and dietary practices. The prime questions of practical concern are related to the need for capabilities to monitor the environment, to make predictions as to what will happen from known or predicted injections of contamination into the environment and finally to reduce the exposure of the human population. Discussion is limited to those radionuclides of major importance, namely, iodine-131, strontium-90, and cesium-137. Strontium-89 is not treated separately because its potential contribution to radiation exposure of the population is much less than that from strontium-90, and its metabolic behavior is the same as described for strontium-90. No consideration is given to carbon-14 since the levels in the population will be unaffected by agricultural and nutritional practice; the specific activity of carbon-14 in the population will reflect that in the atmosphere surrounding crop plants with a time lag of about a year. (auth)

Metabolism, Tissue Distribution, and Toxicology

3450 (BNL-6913) ORGAN AND TISSUE RADIOACTIVITY FOLLOWING PARENTERAL ADMINISTRATION OF Co^{60} VITAMIN B_{12}. Leo M. Meyer, Dorothy H. Driscoll, Eugene P. Cronkite, and Robert W. Bertcher (South Nassau Communities Hospital, Oceanside, N. Y. and Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 19p.

Vitamin B_{12}, labeled with Co^{60} having a specific activity of 1.0 $\mu C/\mu g$, was administered to 18 patients in the late stages of malignant diseases. Death occurred 11 hr to 695 days after $Co^{60}-B_{12}$ administration. Data are presented on the distribution of $Co^{60}-B_{12}$ in tissues and organs obtained at post-mortem examination. From 16.6 to 108% was in the liver, with lesser amounts in the other organs and tissues. Variations resulted from the route of administration, disease state, and interval between administration and death. (C.H.)

3451 (COO-228(p.133-09)) INCORPORATION OF VARIOUS METAL IONS INTO IN VITRO PRODUCED MELANIN. F. W. Bruenger and B. J. Stover (Utah. Univ., Salt Lake City. Coll. of Medicine).

The uptake of various nuclides by melanin produced in vitro is presented. The mutual affinity of the alkaline earth metals and melanin increases with increasing atomic weight. Some elements of group 3A of the periodic table show a higher affinity for melanin than alkaline earths. (auth)

3452 (NP-13178) FEEDING OF DOGS, RABBITS AND HAMSTERS WITH IRRADIATED SHRIMP AND ITS EFFECT UPON THYROID ACTIVITY (PHASE 1). Progress Report No. 10, Six Months Ending March 15, 1963. D. F. Watson, K. G. Libke, R. M. Smibert, and R. W. Engel (Virginia. Agricultural Experimental Station, Blacksburg). Contract DA-49-007-MD-784. 10p.

A diet containing irradiated shrimp as 35% of the solids had no effect on thyroid activity or hematological data of dogs and rats. (C.H.)

3453 (TID-19757) DIFFERENTIAL ACCUMULATION OF STRONTIUM, CALCIUM AND OTHER ELEMENTS BY CORN (ZEA MAYS L.) UNDER GREENHOUSE AND FIELD CONDITIONS. Dale E. Baker, W. I. Thomas, and G. W. Gorsline (Pennsylvania State Univ., University Park). [1963]. Contract AT(30-1)-2744. 16p.

Five single-cross corn hybrids were grown under both greenhouse and field conditions to determine the effect of gross changes in environment on differential accumulation of ions. Analysis of variance data and correlations indicated that the hybrids accumulated different amounts of Sr, Ca, Mg, K, P, Mn, Fe, B, and Zn under both environments. The accumulations of Cu and Al were not significantly different for the five hybrids included in the experiment. It was concluded that differential accumulation of elements by mature corn hybrids grown in the field can be predicted from the results for young plants of the same hybrids grown in the greenhouse; all hybrids must be grown on a uniform substrate and be at the same stage of development when they are removed for analysis; ear leaves collected from hybrids in the field at about 30 days post-silk provide an adequate estimate of whole-plant accumulations of Sr, Ca, Mg, and P, but possibly not for K; and hybrids which accumulate relatively large or small concentrations of one ion do not accumulate all ions in the same relative manner, indicating that differential accumulation results from independent mechanisms which are under different genetic control. (auth)

3454 (TID-19786) [ACCUMULATION OF ELEMENTS IN CORN]. Progress Report Covering Overall Research Activities Over a Three Year Period, March 1, 1961–February 28, 1964. (Pennsylvania State Univ., University Park). Nov. 1963. Contract AT(30-1)-2744. 6p.

Results are reported from studies of the genetic control of the accumulation of certain elements in corn leaves. Emphasis was placed on the accumulation of Ca and Sr. The correlation of the level of Ca and Sr accumulation in leaf tissue with the accumulation by the whole plant appeared to be high enough that leaf tissue analysis is an adequate measure of genetic differences involving whole-plant accumulation. Results indicate that plant breeding efforts would be successful in reducing corn Sr and Ca if it became desirable. Studies of the relations of Ca and Sr to 9 other elements indicate that the relations to other elements are identical. The comparison of greenhouse and field studies indicates that genetic differences in mineral absorption shown by seedlings and young plants are maintained through the entire life cycle. (C.H.)

3455 (JPRS-21997) SOME DISTRIBUTION CHARACTERISTICS OF Sr^{90} IN THE SKELETON OF DOGS AFTER SINGLE AND LONG-TERM ADMINISTRATIONS. A. A. Yusupov. Translated from Uzbeksk. Biol. Zh., 7: No. 4, 35-6(1963). 5p. (OTS-63-41212)

Studies were made of Sr^{90} distribution in the bones of dogs after single- and long-term oral administration. Strontium-90 in different proportions with Y^{90} was given once in a dose of 0.15 mC/kg to nine dogs, over a period of months in doses of 0.002 mC/kg to six dogs, and in a dose of one mC/kg to nine dogs. Animals were sacrificed at various periods after the administrations and bones were examined autoradiographically. Except for a higher concentration in long bone diaphyses after long-term administration, little difference was detected in the concentrations resulting from the two types of administration. In long bones Sr^{90} concentrations were higher in the epiphyses in both cases. Distribution in vertebrae and the sternum was generally uniform. Larger quantities of the isotope were found in the incisors than in molars and premolars with

the dentine bearing the major portion of the burden. Unequal distribution was found in the mandible. (H.M.G.)

3456 (JPRS-22034) THE BUILD-UP FACTOR OF THE RADIOISOTOPES OF SOME CHEMICAL ELEMENTS IN AQUATIC INSECTS. G. A. Volkova. Translated from Entomol. Obozrenie, 42: 516-19(1963). 8p. (OTS-63-41234)

The build-up of P^{32}, S^{35}, Fe^{59}, Co^{60}, Zn^{65}, Sr^{90}, Y^{91}, Ru^{106}, Ag^{111}, I^{131}, Cs^{137}, Ce^{144}, Pm^{147}, and Hg^{203} by the larvae of certain aquatic insects was measured. The insect larvae were those of May flies (Cloeon dipterum), caddis-flies (Glyphotaelium punctatolineatus), dragon flies (Leucorrhinea rubicunda), and drone flies (Eristalis tenax). The build-up factors varied from one to thousands, depending on the element. Some variation among insects was also noted. Data are tabulated. (C.H.)

3457 THE FATE OF Cd^{109} IN THE MOUSE. M. Berlin and S. Ullberg (Karolinska Institutet, Stockholm). Arch Environ. Health, 7: 686-93(Dec. 1963).

The body distribution of Cd in mice killed at various times, from 5 minutes to 16 days, after a single intravenous dose of 8 μC $Cd^{109}Cl_2$, carrier free, was studied by autoradiography of sagittal whole-body sections. The relative order of concentrations found in the organs of the body was estimated by densitometry. The distribution is described in detail. The results indicated excretion of Cd by gastric and colonic mucosa and in the bile. Very little elimination of Cd, however, was found to occur during the 16 days of observation. Cd concentration was seen to decrease only in the mucosa of the intestinal tract, where it fell rapidly after 24 hr. Considerable amounts of Cd were demonstrated for the first time in the interstitial tissue of the testes and in the posterior and anterior lobe of the hypophysis. A distinctive pattern of localization in the renal cortex was also found, indicating selective accumulation in special structures. (P.C.H.)

3458 THE EFFECT OF CARRIER ON THE BUILD UP OF CONCENTRATIONS OF RADIOACTIVE ISOTOPES IN PLANT OR ANIMAL CELLS FROM AQUEOUS MEDIUM. Roland Glaser (VEB Entwichlung und Projektierung Kerntechnischer Anlagen, Berlin and Institut fur Angewandte Isotopenforschung der DAW, Berlin). Biol. Zentr., 81: 539-47(Sept.-Oct. 1962). (In German)

A working hypothesis was proposed for the carrier dependence of the enrichment of radioisotopes in water organisms: in each organism exists a storehouse with constant concentration and a concentration that is proportional to that of the surrounding water. Results are presented in tables and graphs. (M.C.G.)

3459 ACCUMULATION OF RADIOACTIVE STRONTIUM BY HYDROPHYTES AND DETRITUS. A. L. Agre and M. M. Telitchenko. Federation Proc., Transl. Suppl., 22: T1218-19(Nov.-Dec. 1963).

Uptake and accumulation of Sr^{90} was studied in several species of green algae, blue-green algae, diatoms, mosses, and in duckweed. The organisms were placed in experimental solutions made of standing tap water into which Sr^{90} was introduced as $SrCl_2$. Activity of the solutions was 10^{-6} to 10^{-5} Curie per liter. Radioactivity of the organisms was determined every 25 days on a B unit with an SI-2B lead-shielded end-window counter according to standard method. The values of the coefficients of Sr^{90} accumulation by the hydrophytes were found to be inversely proportional to the isotopic concentration of the medium. Algae had higher Sr^{90} accumulation coefficients than did mosses, and the accumulation in algae was more rapid. Experiments showed that organic wastes effected 80% decontamination of the solutions, on the average. It is suggested that hydrophytes and organic wastes may consequently be used for decontamination of water containing Sr^{90}. (H.M.G.)

3460 EFFECTS OF ZIRCONIUM CITRATE ON EARLY FEMUR UPTAKE AND URINARY EXCRETION OF RADIOISOTOPES. Bergene Kawin (Univ. of California, Berkeley). Health Phys., 9: 1031-4(Nov. 1963).

Effects of single intraperitoneal administration of nonradioactive zirconium citrate on femur uptake and urinary excretion of either simultaneously injected intravenous Ce^{144}, Pu^{239}(VI) or Y^{90} were compared in rats during the initial post-injection hour. Zirconium treatment was associated with increased plasma disappearance of Pu^{239}. Comparisons in control and treated animals indicate that zirconium citrate treatment has no effect to alter rates of femur deposition for the early time interval studied, and that it enhances urinary excretion of Ce^{144} and Y^{90}, with only a very small effect on Pu^{239} excretion. (auth)

3461 RADIOMETRIC ANALYSIS OF TRIPHENYL TIN ACETATE IN THE METABOLISM OF PLANTS AND ANIMALS. J. Herok and H. Goette (Farbwerke Hoechst AG, Frankfurt am Main). Intern. J. Appl. Radiation Isotopes, 14: 461-79(Oct. 1963). (In German)

Triphenyl tin acetate is distinguished by an outstanding fungicidal action and is, therefore, used as an active ingredient of the plant protection agent Brestan. Since little is known about the behavior of tin-organic compounds in the metabolism of plants and animals, the question of absorption, passage, and accumulation was examined by means of a radioactive-labeled ingredient. Descriptions are given of triphenyl tin acetate (Sn^{113}) preparation, experiment, arrangement, and the analysis. The results show that the active ingredient is absorbed by the plant neither through the leaves nor the roots. Animals that take in the active ingredient, perhaps during harvesting time as residue on green fodder, very rapidly excrete it almost completely with the dung. Small amounts which are absorbed are partly discharged in the urine, partly distributed over the whole body, broken down, and within a few weeks also excreted. A graphical analysis of the excretion curves shows that the active ingredient leaves the body with a biological half life of 20 hr while its metabolic products have a biological half life of 8 or 70 days, the latter being attributed to inorganically bound tin. (auth)

3462 MOVEMENT OF ^{137}Cs ACROSS SURVIVING INTESTINAL SEGMENTS IN VITRO. W. Moore, Jr. and C. L. Comar (Cornell Univ., Ithaca, N. Y.). Intern. J. Radiation Biol., 6: 507-11(June 1963).

A net transfer of cesium-137 from the mucosal to the serosal side of surviving intestinal segments did not occur when in vitro procedures were used. However, a net transfer of Cs^{137} occurred from the serosa to the mucosa, suggesting the presence of a mechanism for the transfer of Cs^{137} in this direction. The importance of this mechanism is not known. (auth)

3463 THE ACCUMULATION OF Cs^{137} BY BRACKISH WATER INVERTEBRATES AND ITS RELATION TO THE REGULATION OF POTASSIUM AND SODIUM. G. W. Bryan (Marine Biological Association, Plymouth, Eng.). J. Marine Biol. Assoc. U. K., 43: 541-65(1963).

Relations between the ability of brackish water invertebrates to regulate Na and K and the extent to which the radioactive fission product Cs^{137} can be accumulated were studied. The brackish water isopod Sphaeroma hookeri and the gastropod Potamopyrgus jenkinsi were acclimatized to a wide range of sea-water dilutions. Uptake of K^{42} and Cs^{137}

from solution was examined in both species over a range of sea-water concentrations. All the body K is exchangeable with K^{42}, and in Sphaeroma, exchange of K^{42} between the blood and tissues is so rapid that the body surface appears to be the limiting factor in the uptake of the isotope. Both species exchange K^{42} more rapidly in the higher concentrations of sea water; one reason for this may be the existence of an exchange diffusion component of exchange that increases as the salinity of the medium is raised. Indirect evidence suggests that the excretion of K^{42} in urine is probably not an important factor in exchange. The behavior of Cs^{137} generally resembles that of K^{42} although some tissues rather than the body surface are probably the limiting factor in uptake. In Sphaeroma, Cs^{137} equilibrium concentration factors for whole animals are roughly double the values for inactive K as a result of blood/medium and tissue/blood ratios for Cs^{137} exceeding those for inactive K. Equilibrium Cs^{137} concentration factors in Sphaeroma vary from about 7 in 100% to 200–300 in 2.5% sea water. Potamopyrgus attains higher concentration factors for Cs^{137} than inactive K in 100, 25, and 5% sea water but at lower concentrations the factors are below those for inactive K. In 100% sea water, Potamopyrgus reaches a Cs^{137} concentration factor of about three while in 0.1% sea water, a factor of about 300 is reached. It is suggested that in accumulating Cs^{137} to high levels in dilute media, brackish water species are potentially much more hazardous for human consumption than marine species. For this reason, introduction of radioactive reactor wastes containing Cs^{137} into waters of low salinity should be avoided. (BBB)

3464 BREATH ACTIVITY INVESTIGATIONS FOR PATIENTS AFTER TREATMENT WITH I^{131}. S. Fényes and J. Toperczer (Onkologischen Institut, Budapest). Nucl. Med., 3: 280-5(1963). (In German)

The radioactivity of the exhaled breath in patients was measured following therapy with I^{131}. The results varied considerably and were dependent to a large extent on whether the patients coughed, spoke, or breathed regularly or irregularly. The organs of external secretion such as the salivary glands and the bronchi excreted part of the administered radioiodine which was dispersed via the exhaled breath in small droplets throughout the air of the hospital ward, thereby allowing it to be inhaled by untreated patients or by attending personnel, or to be adsorbed onto dust and precipitated on the floor of the ward. There was no relation between dose administered and the fraction liberated via the exhaled breath. In general, 48 hr after ingestion of the radioiodine radioactivity could no longer be found in the exhaled breath. The contamination of the air of the ward was calculated from the results of the breath measurements, and these were in good agreement with the results of direct measurements. (auth)

3465 PRODUCTION OF I^{132} AND ITS USE IN 3-HOUR THYROID UPTAKE TEST. Oskar Chomicki, Tadeusz Gorowski, and Tadeusz Zeleny (Medical Academy, Warsaw). Polski Tygod. Lekar., 18: 1249-51(Aug. 19, 1963).

A method for obtaining I^{132} from Te^{132} is described and its effectiveness in testing thyroid uptake in normal individuals and patients suffering from various thyroid diseases was studied. It was concluded that the 3-hour I^{132} uptake test is most reliable, and its diagnostic value equal, or better than the T_{24} I^{131} test. (OTS)

3466 METABOLISM OF ANTIMONY OXIDE LABELED WITH Sb 124. I. Klucik, M. Beno, F. Trnovec, and V. Zboril. Pracovni Lekar., 15: 323-9(Oct. 1963). (In Czech)

Metabolism of antimony oxide was studied in 26 rats after intratracheal application and in 18 rats after peroral administration. After a single intratracheal application of $Sb_2^{124}O_3$ in a suspension of water solution of sodium carboxymethylcellulosa the Sb was resorbed and stored in the organs in a quantity one order higher than after single peroral administration. The highest percentage of activity was found in the liver and the blood. In the course of observation a significant fall of activity was registered in the liver but not in the blood. The elimination of Sb in the urine and stool may be expressed in square root functions. N,N-diethyldithiocarbamate sodium did not accelerate the elimination of Sb_2O_3 which was administered as a solution. (auth)

3467 THE METABOLISM OF ANTIMONY. D. Djuric. Pracovni Lekar., 15: 329-34(Oct. 1963). (In Czech)

A study was made of the distribution and excretion of trivalent antimony after inhalation in rats. In this study $Sb^{124}Cl_3$ was used. Results of the inhalation exposures show the typical rapid early loss from lung with a somewhat exponential loss of longer biological half life (~100 days) after the 20th day. Serial sacrifice and tissue distribution indicated primary sites of Sb concentration, other than lung, to be whole blood, spleen, heart, and other highly vascularized tissue. On a long range or a continuous exposure basis, the critical organ based strictly upon an Sb concentration would be the circulating blood, and primarily the red blood cells. Excretion and whole-body counting data are included. Although Sb localizes greatly in red blood cells of the rat, this is not evident in the rabbit or dog. (auth)

3468 SELENIUM AND VITAMIN E INFLUENCE UPON THE IN VITRO UPTAKE OF Se^{75} BY OVINE BLOOD CELLS. P. L. Wright and M. C. Bell (Univ. of Tennessee, Oak Ridge). Proc. Soc. Exptl. Biol. Med., 114: 379-82(Nov. 1963).

Whole blood from ewes being fed a purified diet containing urea as the sole nitrogen source was used to determine the in vitro uptake of selenium by ovine blood cells. Selenium-75 as selenite moved into the ovine blood cell in vitro via an oxygen-dependent transport mechanism. The magnitude of this influx was inversely proportional to the dietary intake of selenium, but was not affected by dietary vitamin E. The uptake of sulfur, zinc, or cesium was not influenced by dietary selenium level. (auth)

3469 CALCIUM METABOLISM IN THE RAT STUDIED WITH $CALCIUM^{45}$: EFFECT OF AGE. G. Milhaud, A. G. Cherian, and M. S. Moukhtar (Institut Pasteur, Paris). Proc. Soc. Exptl. Biol. Med., 114: 382-4(Nov. 1963).

The calcium metabolism of adult rats (1 year old) was compared with that of young growing rats (2 months old) by balance studies and tracer calcium. In the adult rats the mass of exchangeable calcium, bone anabolism, bone catabolism, intestinal absorption and balance are reduced; but urinary excretion of calcium remains unchanged. Similarities were noted between the effects of aging and those previously reported for hypophysectomy. (auth)

3470 DISTRIBUTION OF Se^{75} IN SERUM PROTEINS OF CHICKS AND INFLUENCE OF SELENIUM ON ALBUMIN RECOVERY. Elmer D. Walter, Leo S. Jensen, and Jack S. Dunlap (Washington State Univ., Pullman). Proc. Soc. Exptl. Biol. Med., 114: 527-30(Nov. 1963).

Se^{75} was orally administered to 3-week-old chicks fed either selenium deficient or supplemented diets. Distribution of Se^{75} in serum proteins with time and its effect on serum protein pattern were determined electrophoretically. Selenium in the diet had no effect on the distribution of

Se^{75} in the protein fraction, but markedly decreased its retention. After two hours the major portion of the dose was found in the beta and gamma fraction and the activity in this fraction increased with time. Marked increases in albumin/globulin (A/G) ratios in depleted chicks were observed within 96 hours after administration of Se^{75}. Albumin was increased and globulin fractions were decreased. Increases in A/G ratios, somewhat smaller in magnitude, were also noted in chicks receiving a diet supplemented with selenium. (auth)

3471 THE INTERNAL RADIOACTIVE CONTAMINATION OF THE ORGANISM. S. Bergheanu, O. Cavulea, and S. Popescu. Rev. Sanit. Mil., 59: 407-12(May-June 1963).

After emphasizing that the biological effects of irradiation within the organism are similar to those due to external exposure, the various possible sources of such internal contamination are discussed. The diffusion of radioactive isotopes in the organism and the various factors enhancing the danger of radioactive contamination by a given substance are also considered. The radioisotopes are grouped according to their characteristics into 4 toxicity classes, and the various medical-clinical measures suitable for the prevention and treatment of internal radioactive contamination within each group are reviewed. (OTS)

3472 THE DISTRIBUTION OF Rb^{86} IN THE DOGS HEART. B. Malamos, S. Moulopoulos, P. Kostamis, E. Paraschou, and K. Elias (Univ. of Athens and Alexandra Hospital, Athens). 11p. (CONF-164-9)

From Society of Nuclear Medicine 10th Annual Meeting, Montreal, June 1963.

In vivo measurements of the regional myocardial Rb^{86}-uptake were performed in dogs with open chest, using a small ophthalmic β counter. Myocardial tissue specimens from several regions of the ventricular wall were measured in a well-type counter. The preponderance of the left ventricular uptake against that of the right ventricle was confirmed. Furthermore, a significant difference was observed between the base and the apex of the left ventricle, with a higher uptake at the basal regions. No satisfactory explanation of this finding is offered. There was no uniform premortal change in the distribution of the isotope over several regions of the ventricular wall. (auth)

3473 CORRELATION BETWEEN INGESTION, BODY BURDEN AND EXCRETION OF CESIUM-137 IN MAN. Susumu Suguri, Satoru Ohtani, Jun Akaishi, and Naofumi Makino (Japan Atomic Energy Research Inst., Tokyo). 14p. (CONF-67-35)

From Health Physics Society 8th Annual Meeting, New York, June 1963.

The body burden of cesium-137 was measured with a whole body counter, and the results were 3.9 nC in March and April 1961 and 4.2 nC in August 1962. The measured results were compared with the dietary intake of Japanese and the fraction reaching the body by ingestion was about 0.9, assuming that the biological half life of cesium-137 was known. Five subjects were measured for body burden and daily urinary excretion of cesium-137. The results were 4.2 nC and 18 pC/day respectively, and the total amount excreted was 0.7 for the same effective half life. (auth)

Radiation Effects

3474 (BNL-6857) EFFECTS OF HEAVY COSMIC RAY PARTICLES ON CORN SEEDS. Howard J. Curtis and Harold H. Smith (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 10p.

Corn seeds of a special genetic stock were recovered from two satellite flights, and the plants grown from them were examined for abnormalities. Some evidence for a slight increase in chromosomal deletions was observed, which was predicted from the flux of heavy cosmic ray primary particles. Nothing unpredicted was observed. (auth)

3475 (BNL-6858) THE EFFECT OF CHRONIC GAMMA IRRADIATION ON APICAL DOMINANCE OF TREES. Karl Sax and Lloyd A. Schairer (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT-30-2-GEN-16. 15p.

Cherry and apple trees subjected to low doses of gamma irradiation (average of 16 and 34 r/day) for 10 years produced atypical branch development and reversal of dominance which could be attributed to the decrease or inactivation of auxin resulting from the irradiation. (auth)

3476 (BNL-6869) EFFECTS OF IONIZING RADIATION ON ECOSYSTEMS. George M. Woodwell (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 25p.

The nature of changes that might be induced in ecosystems by ionizing radiation is discussed. Effects of ionizing radiation were studied in two ecosystems at opposite extremes of the temporal sequence characteristic of the Aeciduous Forest: an old field and a near-climax forest. The same general plan of irradiation was used in both systems. A centrally located gamma source produced exposure rates ranging from several thousand r/day within a few meters to about 2 r/day at 130 meters. Highest exposures, continued chronically throughout the winter and spring of 1961-62, caused devastation of both ecosystems. The old-field plant community was intact at daily exposures below about 300 r/day, but the forest suffered loss of the principal plant species contributing to its structure at exposures in excess of 60 r/day. It is evident that there is great variation in radiosensitivity among the plant species of the two ecosystems. The forest ecosystem, considered as a unit, was much more sensitive than the old-field, the difference spanning a factor of 5-10 in exposure necessary to produce equivalent change in structure. This difference is most likely attributable to differences in stage of succession of the two systems. An hypothesis derived and evaluated from the age/sensitivity relation was that organisms capable of surviving in harsh environments are more radioresistant than organisms of more equable regimes. Factors contributing to the radiosensitivity of various components of the two ecosystems are discussed. (H.M.G.)

3477 (BNL-6892) ACUTE GAMMA IRRADIATION OF QUERCUS SEED—ITS EFFECT ON GERMINATION AND SEEDLING GROWTH. G. R. Stairs (Yale Univ., New Haven. School of Forestry and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-1)-2755. 38p.

Dormant seed of Quercus alba and Quercus rubra were irradiated with gamma rays from Co^{60} to determine the effect on cytological and morphological expression in the resulting seedlings. Investigations included varying moisture content and physiological state of the seed prior to treatment, and preliminary evaluation of induced mutation. The following observations were made. The lethal radiation exposure was the same for both species although there were differences in germination within the treatment range of 1 to 10kr. Quercus alba showed an LD_{50} of 6kr with a significant regression for radiation level. The regression of germination on radiation level was not signif-

icant for seed of Quercus rubra, but germination was suppressed at the higher levels. These species differences are thought to be due more to physiological than genetic factors. Height growth in the two species was complexed by sprouting in reaction to radiation damage of the apical primordia. Seedling height at the end of one year was not a significant measure of radiation damage. The type of sprouting obtained is discussed in relation to diplotonic selection within the irradiated embryonic primordia. Growth of the root at 10 days following inception was established as a macro-measure of genetic damage. Changes in moisture content (above 25%) or metabolic activity prior to germination did not significantly change the response of root growth to radiation exposure. It is suggested that initial root growth is useful as a bioassay of radiation effect on the seed of woody angiosperms where sprouting is common. The range of 1 to 10kr is recommended for use in oak seed irradiation experiments for the induction of mutations. Preliminary evidence at the end of the first growing season indicates that most aberrations observed are generally deleterious to total growth. However, many of the irradiated seedlings were as large as the controls and at least one irradiated seedling was outstanding in total growth. (auth)

3478 (BNL-6898) RADIATION-INDUCED CHROMOSOME ABERRATIONS AND LOSS OF REPRODUCTIVE INTEGRITY IN TRADESCANTIA. D. Roy Davies (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 29p.

The reproductive integrity of single meristematic cells of Tradescantia occidentalis exposed to acute doses of x rays was investigated. The dose response curve was sigmoid and similar to that reported for a variety of mammalian cell lines having a D_0 of 149 r and an extrapolation number of 1.6. Detailed observations were also made of all forms of chromatid and chromosome aberrations induced after irradiating all stages of the mitotic cycle of these same meristematic cells. Attempts were then made to correlate these two sets of data and to equate loss of genetic information to loss of reproductive integrity. (auth)

3479 (BNL-7353) THE CELLULAR DIFFERENCES BETWEEN ACUTE AND CHRONIC NEUTRON AND GAMMA RAY IRRADIATION IN MICE. H. J. Curtis, J. Tilley, and C. Crowley (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 21p. (CONF-205-10)

From International Atomic Energy Agency Symposium on the biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963.

Data from many laboratories are summarized that indicate that for mice the RBE of large single doses of γ rays or neutrons is about the same for shortening of the life span as it is for acute lethality. However, for chronic irradiation the RBE is quite high for shortening of the life span, due to the fact that very small doses of neutrons are proportionately just as effective as large doses, while for γ rays, small doses are proportionately only about $\frac{1}{4}$ as effective as large doses. The reason for this difference was investigated by scoring the chromosome abberations in regenerating liver cells in mice subjected to both chronic and acute neutron and γ irradiations. The results show that for γ rays, very small doses are proportionately only about 25% as effective in producing chromosome aberrations as are large doses. However, for neutrons, large and small doses are proportionately equally effective. This result adequately explains the differences in RBE for life shortening and at the same time gives strong support for the somatic mutation theory of aging. Results indicate that for relatively large doses, equal rad doses of neutrons produce about twice the chromosome damage as do γ rays. This would indicate that the RBE for acute effects can also be explained on the basis of chromosome damage. Following single doses of γ rays, the percentages of abnormal chromosomes falls slowly over a period of many months, but following a single dose of neutrons the aberration frequency may be as high as 90% and stay this high for at least a year. There is no ready explanation for this difference in reaction to these two radiations. (auth)

3480 (COO-228) RESEARCH IN RADIOBIOLOGY. SEMI-ANNUAL REPORT OF WORK IN PROGRESS ON THE CHRONIC TOXICITY PROGRAM. Thomas F. Dougherty (Utah. Univ., Salt Lake City. Coll. of Medicine). Sept. 30, 1963. Contract AT(11-1)-119. 182p.

Sixteen articles including injection tables, are included; separate abstracts were prepared for 12. The articles not abstracted separately in NSA include information on injection tables explanation, current census of the Beagle colony, acute hematological changes following Ra^{224} injection into four Beagles, and measurement of Sr^{90}. (P.C.H.)

For abstracts of individual papers see: 3451, 3481, 3482, 3483, 3484, 3485, 3486, 3487, 3488, 3489, 3490, and 3491.

3481 (COO-228(p.57-9)) NOTE ON THE NEW PROCEDURE FOR PREPARING THE INJECTION TABLES. D. R. Atherton, F. W. Bruenger, and B. J. Stover (Utah. Univ., Salt Lake City. Coll. of Medicine).

Procedures were developed for rapid updating and sorting of data for the Injection Tables and for printing the Tables on multilith masters by computer are described. (P.C.H.)

3482 (COO-228(p.61-5)) COMPLETION OF THE INJECTION PHASE OF THE BASIC TOXICITY EXPERIMENT. Betsy J. Stover, Glenn N. Taylor, and David R. Atherton (Utah. Univ., Salt Lake City. Coll. of Medicine).

Young adult beagles (444) received single intravenous injections of Ra^{226}, Pu^{239}, Ra^{228}, Th^{228}, and Sr^{90} over a period of nearly 11 years. Data on survival are tabulated. (P.C.H.)

3483 (COO-228(p.67-8)) EXTENSION OF RADIUM AND PLUTONIUM STUDIES TO LOWER LEVELS. T. F. Dougherty (Utah. Univ., Salt Lake City. Coll. of Medicine).

Plans are made to inject 160 beagles with Ra^{226} or Pu^{239} when kennel space becomes available. Half of the animals will be observed throughout their lifespan; the others will be sacrificed serially. The main objective is to study the effects of low levels of internal irradiation over a prolonged time. (P.C.H.)

3484 (COO-228(p.69-73)) A PILOT STUDY OF Ra^{224} IN BEAGLES. Charles W. Mays, Glenn N. Taylor, and Jean H. Dougherty (Utah. Univ., Salt Lake City. Coll. of Medicine).

Plans are made to inject a limited number of dogs with 30, 10, or 3.3 μC Ra^{224}/kg. Effectiveness of the sudden dose from the short-lived 3.62 day Ra^{224} will be compared with the continuous irradiation from the long-lived 1620 yr Ra^{226} in the induction of bone cancers and the production of hematological changes. (auth)

3485 (COO-228(p.79-93)) ANALYSIS OF THE EFFECTS OF AGE ON THE HEMOGRAM OF THE BEAGLE. Jean H. Dougherty, Leon S. Rosenblatt, and Fred T. Shultz (Utah. Univ., Salt Lake City. Coll. of Medicine).

A time trend for many hematological values of control

dogs become evident when pre-injection counts were examined over a ten-year period. The changing values must be taken into consideration when evaluating changes in the hemogram with aging. Preliminary analysis indicated that there is a decrease in the volume of packed red cells with age but no significant change in leukocyte values. (auth)

3486 (COO-228(p.95-108)) NON-SKELETAL TUMOR INCIDENCE OBSERVED IN BEAGLES WITH RETAINED BURDENS OF Ra-226, Ra-228, Th-228, Pu-239 OR Sr-90. G. N. Taylor, T. F. Dougherty, and L. Shabestari (Utah. Univ., Salt Lake City. Coll. of Medicine).

Beyond six to seven years age, a significant number of non-skeletal tumors were observed in beagles receiving a single intravenous injection of Ra^{226}, Ra^{228}, Th^{228}, Pu^{239}, or Sr^{90}. Comparison with the control animals tentatively indicated that most of these were naturally occurring tumors and were not radioinduced. The debility and premature deaths arising from the naturally occurring factor were successfully minimized by early surgical care. Such measures to limit the losses from this and other non-radiation induced causes have become especially important at the lower dose levels where long latent periods are anticipated for some of the radioinduced lesions. (auth)

3487 (COO-228(p.109-16)) NEPHRITIS IN DOGS WITH RETAINED Ra-226 BURDENS. G. N. Taylor, C. W. Mays, L. Brewster, and W. S. S. Jee (Utah. Univ., Salt Lake City. Coll. of Medicine).

Nephritis was observed in a high percentage of beagles injected with a single intravenous dose of 1-3 μC Th^{228}/kg, and in dogs treated with high levels of Ra^{228} but in which Th^{228} contamination was present. Similar lesions were observed in a unique group of beagles not born on the project that received 10 μC Ra^{226}/kg. However, an abnormally high susceptibility or other factors may have been involved and the data otherwise indicated that Ra^{226} does not cause a serious nephritis in the dog at injected dose levels up to 10 μC/kg body wt. It is possible that these radioinduced kidney lesions might play at least a limited, indirect role in the production of spontaneous fractures. (auth)

3488 (COO-228(p.117-25)) KIDNEY IRRADIATION FOLLOWING Ra^{226} INJECTION. Charles W. May, Ray D. Lloyd, and Glenn N. Taylor (Utah. Univ., Salt Lake City. Coll. of Medicine).

In beagles injected with radium, the average rad dose (from Ra^{226} + daughters) to the kidney is in the order of 1% of that received by the skeleton. However, this small average physical dose to the kidney may have caused significant biological damage in a group of highly susceptible dogs. (auth)

3489 (COO-228(p.127-31)) LOW UPTAKE OF RADIUM, BARIUM AND IODINE IN SOME MELANOMAS. Charles W. Mays, Glenn N. Taylor, William B. Christensen, David R. Atherton, Webster S. S. Jee, and Wallace S. Brooke (Utah. Univ., Salt Lake City. Coll. of Medicine).

Unlike the large uptake of Ra^{226}, which caused regression in a highly pigmented canine melanoma, small uptakes of Ra^{226}, Ra^{224}, Ba^{140}, and I^{131} in the highly pigmented B-16 mouse melanoma; Ra^{226} and I^{131} in the moderately pigmented M-3 hamster melanoma; I^{131} in the slightly pigmented M-4 hamster melanoma; and Ra^{224} in a very slightly pigmented spontaneous human melanoma were observed. (auth)

3490 (COO-228(p.143-68)) THE EFFECTS OF IONIZING RADIATIONS ON ENDOCRINE CELLS. I. STEROID BIOTRANSFORMATIONS AND ANDROGEN PRODUCTION BY TESTES FROM IRRADIATED MICE. LeGrande C. Ellis and David L. Berliner (Utah. Univ., Salt Lake City. Coll. of Medicine).

Methods are presented for the isolation, purification, and characterization of the intermediates produced when 5-pregnenolone-7α-H^3 and progesterone-4-C^{14} were incubated with mouse testes. With these techniques, it is shown that 17α-hydroxyprogesterone and androstenedione are important intermediates in the formation of testosterone from the 2 substrates. Whole-body irradiation of mice with 540 r decreased testicular weight and produced a biphasic response in steroid biotransformations and androgen production. There was an initial increase in side chain splitting activity followed by a decreased activity which then increased to above normal levels by 30 days post irradiation. A block in the reduction of the oxygen function at C^{17} was also observed until 20 days post irradiation. There was a direct correlation of the production of progesterone and 17α-hydroxyprogesterone, both of which had an inverse relationship with the production of androstenedione. The data were correlated with previously established histologic changes of the cellular elements of the testis. The involvement of pituitary gonadotropins and metabolic cofactors (TPN and DPN) are discussed as possible mediators of the syndrome of effects observed. (auth)

3491 (COO-228(p.169-85)) THE EFFECT OF IONIZING RADIATIONS ON ENDOCRINE CELLS. II. RESTORATION OF ANDROGEN PRODUCTION WITH A TPNH GENERATING SYSTEM FOLLOWING IRRADIATION OF RAT TESTES. David L. Berliner, LeGrande C. Ellis, and Glenn N. Taylor (Utah. Univ., Salt Lake City. Coll. of Medicine).

Testicular tissue from control rats (Sprague-Dawley strain) and from rats irradiated with 1500 r when 12 weeks of age were incubated with 5-pregnenolone-7α-H^3 and progesterone-4-C^{14} 20 days following treatment. It is shown that 17α-hydroxyprogesterone and androstenedione are important intermediates in the synthesis of testosterone by these tissues. Twenty days after irradiation androgen production was markedly reduced in the irradiated group. At this time, essentially two groups of cells remained in the irradiated testes; interstitial elements and Sertoli cells. The addition of a TPNH generating system restored to normal levels the amount of testosterone produced in vitro by irradiated testicular tissue. Localized irradiation of the testes also reduced the conversion of 5-pregnenolone and progesterone into androgens or their intermediates. The decreased amount of substrate ending up as androgens or their precursors was attributed to the conversion of these compounds into metabolites of greater polarity than testosterone. Thus, it was concluded that the diminished testosterone production of irradiated testes was due, in part, to the lack of TPNH or its availability and to quantitative changes in alternate pathways for intermediates formed from 5-pregnenolone and progesterone. (auth)

3492 (TID-18282) PYRIDOXINE ABSORPTION FROM ISOLATED, IRRADIATED RAT INTESTINE IN SITU. L. E. Detrick, H. C. Upham, R. W. Springsteen, R. G. McCandless, and T. J. Haley (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Mar. 21, 1963. Contract AT-04-1-GEN-12. 17p.

An attempt was made to correlate the functional changes in the irradiated intestine during periods of malabsorption with morphological changes seen histologically and under the electron microscope. Ninety-eight control and 115 irradiated rats were studied in groups of 20 to 24 animals per day over a 29-day period. Segments of the small intestine were cannulated at both ends and perfused with fluid containing pyridoxine. The pyridoxine absorption by

the intestine of rats receiving 525 r whole-body x irradiation showed two deviations from the normal absorption pattern. A profound decrease was observed on the third day and a secondary decrease was observed from the 10th to the 17th day post-irradiation. The first absorption decrease was related to direct damage of the premitotic crypt cells. Electron microscopic studies indicated mitochondrial damage from irradiation. The second decrease in absorption was correlated with focal villar degeneration, localized hemorrhage, and the release of histamine and serotonin, all of which could result in the development of an environment unfavorable to essential villar enzymatic activity. (C.H.)

3493 (TID-18352) QUANTITATION OF CELLULAR RESPONSES IN THE MOUSE SPLEEN AFTER IRRADIATION. Austin M. Brues and Agnes N. Stroud (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 26p. (UAC-7252)

Following sublethal whole-body irradiation of young mice, the spleen diminishes in size in relation to dose, then hypertrophies so that after larger doses it much exceeds the original weight. This reflects a very much more rapid regeneration at higher doses than occurs at lower doses. This regeneration takes place largely in proliferating areas within the red pulp. This proliferation is in some cases grossly nodular and in others it is not. When nodules are seen, when they appear, they are fewer and more rapidly growing after higher radiation doses. If those were taken to resemble a survival curve of single colony-forming units, an original population of somewhat more than 100 such units would be indicated. Further work is required to establish whether such a mechanism is active. (auth)

3494 (TID-18386) FRACTIONATED, LOW DOSE-RATE, IRRADIATION OF MICE WITH FISSION NEUTRONS AND Co^{60} GAMMA-RAYS. Howard H. Vogel, Jr., and Donn L. Jordan (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 9p. (UAC-7251)

Data on the comparative effects of fission neutrons and Co^{60} gamma rays on lethality in CF No. 1 female mice are presented. All animals were exposed in the gamma-neutron radiation chamber at the CP-5 reactor. Both radiations were delivered at a dose rate of approximately 1 rad/min. The mice exposed to γ rays received 13 weekly doses of 300 rads, delivered in one, three, or six equal fractions per week. Under the conditions of exposure at CP-5, fission neutrons have been found to be almost three times as effective as Co^{60} γ rays for acute 30-day lethality in the mouse. An RBE value of 5 was arbitrarily chosen as a basis for the selection of the gamma dose. Thus, the total neutron weekly dose was 60 rads (total delivered in three fractionation patterns). The irradiations were continued for 13 consecutive weeks, hence the mice were exposed to almost 4000 rads of gamma rays. The mean survival times of the gamma-irradiated mice are not significantly different whether they are exposed once or three times a week. There is an indication that daily exposure (six times a week) increases the mean survival time, but the numbers are small and the difference may not be significant. There is no such indication for the neutron-irradiated mice. It is clear from the data that the figure of 5 is too high for the neutron/gamma RBE under the conditions of this experiment. Data are given on the number of cases of thymic lymphomas observed at autopsy in the irradiated mice. It is evident that in the neutron-irradiated mice this reticular tumor of the thymus gland is the leading cause of death, whereas the incidence in the γ-exposed mice is much lower. It is probable that this difference is largely an effect of the different times of mortality. (auth)

3495 (TID-19463) EFFECTS OF X RAYS ON MEAL WORM EMBRYOS. [Progress Report]. Donald S. Pochedley (D'Youville Coll., Buffalo). [1963]. Contract AT(30-1)-2814. 6p.

The 17 free amino acids and the 3 derivatives previously reported for the one- and the four-day-old meal worm embryos were found represented for almost all of the remaining days of embryological growth. These compounds showed, generally, an increase in concentration ranging from 152.7 mg per cent for the one day old embryo through 176.7 mg per cent for the eight-day-old embryo. Concentration changes of individual amino acids for the x-irradiated, four-day-old embryo fall according to their behavior into two groups 24 hr post-irradiation. Although the irradiation instituted amino acid transformations and shifts in concentration, a recovery or restoration phenomenon occurred, apparently facilitated by the reserve of free amino acids accumulated at this stage of embryological development. (auth)

3496 (TID-19724) ARTIFICIAL MUTAGENESIS IN PLANTS OF ECONOMIC IMPORTANCE. Angelo Bianchi (Università Cattolica del Sacro Cuore di Milano, Piacenza. Istituto di Genetica). [1963]. Includes Progress Report: INDUCTION OF GENETIC MUTATIONS BY IRRADIATION IN PLANT SPECIES OF ECONOMIC IMPORTANCE. Contract IAEA 64/R/US. 8p.

Progress is reported in studies of mutations in maize, a cross-pollinated plant, and tomato, a self-pollinating plant, induced by chemical mutagens or x radiation. The possibilities of using radioinduced mutations in plant breeding programs are discussed. (C.H.)

3497 (TID-19749) THE EFFECTS OF PRENATAL X-IRRADIATION ON THE BEHAVIORAL DEVELOPMENT OF THE ALBINO RAT. Final Report. Jack Werboff (Wayne State Univ., Detroit. Animal Behavior Lab.) and Melvin R. Sikov (Wayne State Univ., Detroit). 1963. Contract AT(11-1)-821. 7p.

Progress is reported in a study of the effects of doses of x radiation from 0 to 100 r administered to gravid rats on the 5th to the 20th day of gestation on behavioral characteristics measured at various ages. The behavioral measurements included motor maturation of the upright response, motor maturation of the righting response, inclined plane test, motor strength test, locomotor learning test, open field test, maze learning test, and audiogenic seizure test. The data showed that irradiation altered activity and emotionality in the offspring as measured by performance of the tests used. Certain days of gestation produced different results from other days, indicating a stage dependence for radiation injury of the central nervous system. (C.H.)

3498 (TID-19777) COMPARATIVE STUDIES OF THE EFFECTS OF X-RADIATION ON MAMMALS AND PROTOZOA. Progress Report, November 1, 1962–September 1, 1963. Jay S. Roth (Connecticut. Univ., Storrs). Contract AT(30-1)-2737. 35p.

Simplified methods of assays for desoxynucleotide deaminases were developed. Results are reported from studies on the effects of doses of 700-r γ radiation on enzyme activity in organs of normal and tumor-bearing rats. Emphasis was placed on effects on the activity of lysomal enzymes, thymidylate phosphatase, uridylate phosphatase, and desoxynucleotide deaminases in cellular and subcellular fractions of spleen and liver. The effects of irradiation in

the presence of various metabolites on respiration in Tetrahymena were also studied. Results indicated that catalase activity in Tetrahymena may in some measure account for the high resistance of this protozoan to radiation. (C.H.)

3499 (TID-19787) NATURALLY OCCURRING AND ARTIFICIALLY INDUCED MUTATIONS IN MAIZE. Angelo Bianchi (Università Cattolica del Sacro Cuore di Milano, Piacenza. Istituto di Genetica). [1963]. Contract AT(30-1)-2613. 13p.

Results are reported from artificial mutagenesis experiments in maize designed to investigate the nature of induced and inheritable variety. Results are summarized for the scoring about 10,000 F_1 ears for types and frequency of endosperm mutations following chemical and x radiation treatment. Differences in response to x radiation and chemical mutagens are discussed. Evidence is presented for an artificially obtained back mutation in maize. (C.H.)

3500 (UCRL-11005) BIOELECTRIC SENSITIVITY TO IRRADIATION OF THE RETINA AND VISUAL PATHWAYS. C. T. Gaffey and A. K. Kelley (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Donner Lab.). Sept. 9, 1963. Contract W-7405-eng-48. 38p.

A study was made of the acute effects of ionizing radiation on the visual pathways of the cat, as revealed by electrophysiological techniques. Irradiation sources were: 910-Mev α particles from a 184-in. cyclotron, 40-Mev α particles from a heavy ion linear accelerator, and 250-kv x rays. Rotational procedures restricted irradiation to the eye, optic tract, or optic chiasma. The b-wave amplitude of the electroretinogram served as an index of the functional sensitivity of retinal cells to unilateral irradiation. Photically evolved responses from chronically implanted bipolar electrodes in the optic tract provided a quantitative means of evaluating the influence of unilateral optic-tract irradiation. Midline irradiation of the optic chiasma was performed, and blockage of interocular transfer was used as a measure of the effectiveness of irradiation. Ophthalmoscopic examinations were performed on irradiated cats. Tests using 40-Mev and 910-Mev α particles, were carried out, to determine whether ionizing radiation affects the functional state of excitable systems in a manner analogous to electrical stimulation. Efforts were made to evoke with ionizing-radiation action potentials from frog sciatic nerve and internodal Nitella cells. Attempts were made to induce pupillodilation in the nucleus perifornicalis of the hypothalamus of cats, by means of focused ionizing radiation. (auth)

3501 (USNRDL-TR-673) THE EFFECT OF AGE AT IRRADIATION UPON LIFESPAN IN THE MALE RAT. D. C. Jones and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Sept. 10, 1963. 27p. (AD-422739)

Male rats (average number/group = 127) were exposed to a single whole-body high sublethal (30 day) dose of fast neutrons (220 ± 10 rads) at one of five ages ranging from the juvenile to the late adult stages of life. Lifespan functions for these groups were compared with those of littermate controls. For nonirradiated control groups of this Sprague-Dawley strain, the median lifespan was 703 days (S. D. = 41 days). In terms of the median or mean survival time, life expectancy, age-specific death rate, and survival curve, there was a marked detrimental effect of irradiation in animals exposed at one month of age. This radiation effect diminished progressively when exposure occurred at 3 or 10 months of age, and was no longer discernible in groups exposed at 15 or 21 months. For those age groups (1, 3, or 10 months) which exhibited a significant alteration in lifespan functions, there was a latent period of seven to ten months before the effect became apparent. It appears that age at exposure is an important stipulation for consideration of long-term effects of irradiation. Further, it appears that animals exposed to sublethal (acute) doses of radiation after complete maturity has been attained may show little or no alterations in lifespan functions. (auth)

3502 (JPRS-21996) SIGNIFICANCE OF PRESOWING TREATMENT OF COTTON SEEDS WITH PROTISTA IRRADIATED WITH GAMMA-RAYS OF Co^{60}. V. F. Nikolyuk and M. I. Mavlyanova. Translated from Uzbeksk. Biol. Zh., 7: No. 4, 59-61(1963). 7p. (OTS-63-41211)

A study was made of the effect of the infusorian Colpoda maupasi Enriques, irradiated with Co^{60} gamma rays, on the rate of cotton seed germination. Cotton seed of 108-F variety were treated: with azotobacter; non-irradiated infusorians; or infusorians irradiated with 500, 1000, 10000, and 50000 r. Untreated and treated seeds were sown in petri dishes. With doses of 1000 to 50000 r germination was increased, and the plants were larger. Underlying the stimulation effect of irradiated Protista on the development of the plants was an increase in the rate of metabolic processes and an increase in the discharge of metabolites which were growth-producing substances. (H.M.G.)

3503 (JPRS-22001) CHARACTERISTICS OF THE COURSE OF SHOCK CAUSED BY COMPRESSION OF SOFT TISSUES UNDER CONDITIONS OF ACUTE RADIATION INJURY. B. I. Krivoruchko. Translated from Patol. Fiziol. i Eksperim. Terapiya, 7: No. 5, 72-3(Sept.-Oct. 1963). 4p. (OTS-63-41216)

The soft tissues of the thighs of 52 rabbits were compressed by a tourniquet for 4 hr before exposure to a whole-body dose of 600-r x radiation given at a dose rate of 25.8 r/min. Traumatic shock developed immediately, while in control animals severe shock developed after the compression was stopped. A study was made of the blood pressure, EKG, pressor vascular reflexes, adenosine triphosphoric acid, creatinine phosphate, inorganic phosphorus, and lactic acid contents in the brain, respiration, body temperature, and longevity, and measurements were made of carbohydrate-phosphorus metabolism in the brains of 10 rabbits at different stages during the course of shock. Results indicate that under the influence of irradiation with 600 r, a primary reaction occurred that was characterized by disturbances of the reflex regulation of the circulation and relative hypotension. Under these conditions, mechanical injury caused by soft tissue compression aggravated the existing disorders and led to a severe functional disorder of the central nervous system. (C.H.)

3504 (JPRS-22017) HISTOCHEMICAL CHARACTERIZATION OF THE DISTRIBUTION OF RIBONUCLEIC (RNA) AND DEOXYRIBONUCLEIC (DNA) ACIDS IN THE TESTICLES OF RATS AFTER GAMMA-IRRADIATION WITH Co^{60}. A. K. Mirakhmedov. Translated from Uzbeksk. Biol. Zh., 7: No. 4, 55-8(1963). 5p. (OTS-63-41226)

The effects of 400-r whole-body γ radiation on the histological picture and content of RNA and DNA in the testis of mature male rats were measured. The irradiated rats were sacrificed 1, 3, and 4 days, and 1, 2, 8, and 12 weeks after irradiation. Characteristic signs of tissue reaction included reduction in size of the epithelial layer, vacuolization in the parietal layer of epithelium, increase in the number of Sertoli cells, and increase in interstitial cells in

the seminiferous tubules. Degenerative changes were well advanced on the 60th day after irradiation. Changes in RNA and DNA proceeded in parallel with changes in the histological structure and a marked reduction in content was observed on the 60th post-irradiation day. (C.H.)

3505 (JPRS-22122) OSMOTIC STABILITY OF LEUKOCYTES IN PERSONS SUBJECTED TO THE ACTION OF SOME OCCUPATIONAL HAZARDS. A. V. Scheglova. Translated from Probl. Gematol. i Pereliv. Krovi, 8: No. 10, 26-9(1963). 5p. (OTS-63-41280)

The osmotic stability of leukocytes in persons occupationally exposed to small doses of radiation was measured. A slight reduction in osmotic stability was noted. A more marked reduction of osmotic stability was noted in persons exposed to both benzene and γ radiation. (C.H.)

3506 A THEOREM ON THE GENETICS OF SOME CONGENITAL MALFORMATIONS. Paul de Bellefeuille (Univ. Ottawa). Acta Genet. Statist. Med., 12: 123-35 (1962).

From a consideration of the empirical risks of repetition of cleft lip, cleft palate, and pyloric stenosis within a family, a general theorem was devised in which genetic moiety, neomutational portion, dominance, and penetrance were interrelated. This theorem made possible the calculation of estimates for these parameters and offered an explanation for certain paradoxes in the distribution of the cases in the family. It was likely that such conditions do have a partial genetic etiology, with reduced penetrance, and that dominance varies from trait to trait. A portion of the occurrence of these congenital anomalies can be ascribed to mutations arising in each generation. An example is cited of a mutagenic influence that might increase the incidence of malformations, namely, the exposure of human populations to ionizing radiation, and a quantitative estimate of the latter risk was proposed. That the fraction (m) of congenital anomalies due to radiation appears small for two of the traits discussed is not surprising, inasmuch as these conditions are compatible with survival and retention of a good part of reproductive fitness. Accordingly, higher values of m should be expected for the more severe anomalies that are lethal or entail a near-complete loss of reproductive fitness. Unpublished results on major congenital anomalies in large populations gives evidence suggesting a minimum mean value m = 0.35 for the ensemble of such cases. The importance of the parameter m lies in the prediction of the effect of a given mutagenic influence upon the incidence of developmental defects. This can be expressed by $i = (D_m)/(D_2)$, where i is the increase in incidence in the offspring of the parental generation (P_1) to which is applied a dose D of an influence for which the mutation-doubling dose is D_2. In the case of the diagnostic use of x-rays in North America at this time (estimated at 4.5-r gonad dose per 30 yr, i.e. per generation) substitution in the equation of the value m = 0.35 leads to an estimate: $i = (4.5 \times 3.5)/30 = 0.05$, i.e., a 5% increase in the incidence of congenital malformation in the first filial generation, D_2 for x rays being provisionally estimated at 30 r. The role of the portion (g) of genetically transmitted anomalies must also be considered since the genetic moiety is all mutational in origin: some of it (m) arising in the present parental generation, the remainder (g_1) having arisen in an indefinite number of generations prior to the P_1. While an increase in m is expected in the first filial generation (F_1) from a dose D_2 applied to the P_1, a total increase in g will result, spread over the entire posterity. If D_2 is applied to all succeeding generations (permanent doubling), the expected increase per generation rises from m to reach g at equilibrium (after many generations). The question of the induction of mutations by radiation is a vital one, and contrary to the negative impression favored by some official spokesmen, it has been shown that paternal irradiation by the atomic bombs in Japan was followed by a statistically significant increase of reproductive wastage in the offspring and that the magnitude of the increase in major congenital malformations was quite near that expected in the F_1 from the estimated amount of radiation received. This was of the order of a 1% increase per roentgen gonad dose. (BBB)

3507 EFFECTS OF ROENTGEN IRRADIATION OF THE JAWS ON SOCKET HEALING IN YOUNG RATS. Asger M. Frandsen (Royal Dental Coll., Copenhagen). Acta Odontol. Scand., 20: 307-34(1962).

The pathogenesis of radioosteomyelitis was investigated by x irradiating the molar regions of rats, 52 to 60 days old, at single doses of 1725 and 2400 r. The lower left first molars were extracted either 8 days before irradiation or 5 days after. The observed gross pathologic changes included epilation, erythema, and exudation in the irradiated skin area, and oral changes varying from minor lesions of the floor of the mouth to severe radioosteomyelitis of the jaw with occasional orocutaneous fistulae. The frequency of radioosteomyelitis was 5–6 times greater in rats irradiated before extraction than in those irradiated after the extraction. Microscopically, bone and periodontal membrane necrosis in the socket wall was demonstrated shortly after the extraction. Granulation tissue organizing the clot showed low cellularity, and epithelial proliferation was impaired. Bone resorption was prominent, but areas with bone formation were also seen. The cellular inflammatory response to surface defects and sequestra was absent in some rats whereas pus accumulation was seen in other irradiated rats. Vascular changes consisting of proliferation of endothelial cells with large nuclei were occasionally noted. When radioosteomyelitis was present, it was characterized by a penetrating destruction of the mandible spreading far beyond the socket area and causing extensive sequestration. Apparently, the irradiated tissues had little capacity of limiting or repairing the damage. It is concluded that if irradiation is postponed until the socket becomes sealed off by organization of the clot and epithelial healing, the changes of radioosteomyelitis development are greatly reduced. (BBB)

3508 RADIATION-INDUCED CARDIAC FIBROSIS. Emanuel Rubin, Jesus Camara, David M. Grayzel, and Frederick G. Zak (Mt. Sinai Hospital, New York). Am. J. Med., 34: 71-5(Jan. 1963).

Three cases of cardiac fibrosis are described in which radiation is suggested as the cause. In Case I, death occurred as a result of fibrosis involving the conducting system 23 yr after irradiation; in Case II, rupture of the apex of the heart occurred 14 months after radiotherapy. In Case III, cardiac fibrosis was asymptomatic. Although the exact dose of radiation in Case I was not known, it was large, since necrosis of skin and ribs ensued. The dose (4455 rad) in Case III would ordinarily be expected to result in only transient electrocardiographic changes rather than in permanent damage. The absence in Case III of gross or microscopic occlusive coronary artery disease, the patchy distribution of the fibrosis, and its localization to the anterior wall of the heart, especially the right ventricle, all speak against coronary arteriosclerosis and for radiation as the causative factor. In Case I the observed bizarre pleomorphic nuclei, the giant cells in arteries

near fibrotic areas, and hyalinized vessels were consistent with a radiation effect. Histologically, the process in both hearts appeared to be inactive. In Case I the fibrosis apparently progressed slowly, presumably aggravated by compromised vascular supply on the borders of fibrotic areas because of radiation-induced vascular injury. Symptoms of heart block appeared only after the focal fibrosis in the septum had extended sufficiently to interfere with the conducting system. In Case II, despite the presence of adjacent bacterial infection, the changes in the heart were unquestionably radioinduced. The degree of damage to the skin and ribs is out of proportion to the estimated dose 2920 rad) of radiation, which was probably greater than originally calculated. In this case death was caused by rupture of the myocardium in an area in which the circulation was severely compromised by radiation damage. These data suggest that radiation for malignant disease may result in permanent cardiac fibrosis as well as functional cardiac abnormalities. Such damage might assume greater importance in a heart already damaged. It is suggested that the diagnosis of radioinduced cardiac fibrosis be entertained in radiated patients who exhibit unusual clinical or electrocardiographic evidence of heart disease. (BBB)

3509 THE EFFECT OF 5.3 Mev Po^{210} ALPHA PARTICLES ON THE RESTING MEMBRANE POTENTIAL AND ULTRASTRUCTURE OF NITELLA FLEXILIS. Rudolf M. Bergstroem (Univ. of Helsinki). Ann. Med. Exptl. Biol. Fenniae (Helsinki), 40: 45-53(1962).

Young internodal cells of the freshwater alga Nitella flexilis were irradiated with 5.3-Mev Po^{210} alpha particles, and the resting membrane potential of the cells measured over a period of 48 hr after the irradiation. The results showed that a significant decrease in the potential could be obtained with doses of more than 20,000 rep. With a dose of 50,000 rep, the decrease was 50% of the initial value in about 24 hr. Electron microscope studies showed that in all cases in which there was a drop in the potential due to the irradiation, there occurred a separation of the protoplasm from the cell wall. (P.C.H.)

3510 HEMATOLOGICAL EVOLUTION OF PATIENTS EXPOSED TO WHOLE-BODY IRRADIATION FOR ORGAN TRANSPLANTATION. M. Tubiana and C. M. Lalanne. Ann. Radiol., 6: 561-80(1963). (In French)

Single, uniform, whole-body irradiation, at doses from 400 to 500 rads, produces a prolonged aplasia of the bone marrow and circulating blood and a considerable change in the general condition of the patient. However, none of the seven patients so treated and followed for a sufficient period of time has died from the effects of the irradiation. This is due, no doubt, to the exercise of aseptic precautions that would seem to have prevented exogenous infections. In the comparison of patients receiving different doses, it was found that the higher the dose, the faster was the fall in the blood cell count and the more marked was the marrow aplasia. Within the limits of the doses used, it appears that regeneration was faster for those patients whose aplasia occurred the earliest. The effects of a dose of 400 rads in one treatment or of a total dose of 450 rads in two treatments separated by an interval of several days would seem to be comparable, except, possibly, for the lymphocyte counts upon which the fractionated doses produced less lasting changes. Finally, irradiation seemed to have improved, at least temporarily, the tolerance of all the patients for kidney transplants. (auth)

3511 EXOGENOUS FACTORS IN THE CAUSATION OF TUMORS. R. Vannugli. Ann. Sanita Pubblica, 21: 1395-1444(Nov.-Dec. 1960). (In Italian)

The role of ionizing radiation and other external agents in carcinogenesis is reviewed. (BBB)

3512 INFLUENCE OF X-RAY IRRADIATION ON THE CENTRAL NERVOUS SYSTEM OF ALBINO RATS ON THE GLYCOGEN CONTENT IN THE LIVER CELLS. Irena Krolikowska-Prasal and Jerzy Szydlowski (Medical Academy, Lublin). Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. D, 16: 93-107(1961), (1962). (In Polish)

The effect of head irradiation of adult rats with 190-kv x rays at a rate of 25r/min on the glycogen content of liver cells was studied. The 75 experimental animals received single head doses of 600 or 1200 r, or two 600 r doses at a 24-hr interval. The animals were killed immediately or after 2 hr, 24 hr, 7 days, or 21 days, and liver thus obtained was studied by the histochemical method of Best and by the photometric anthrone method. The liver tissue, in the absence of a local action of ionizing radiation, presented metabolic and enzymatic changes that could be detected by histochemical and chemical methods. A decrease of the glycogen content, which was observed during the first hours after irradiation of the central nervous system, probably resulted from the loss of appetite and of associated digestive disturbances, superimposed on the complex general irradiation reaction. The observed later (at 12–24 hr) increase of glycogen may have been the result of the action of the compensatory system of pituitary gland and adrenals, reacting to the stimuli of fasting and irradiation. It is concluded that the considerable fall in liver glycogen after 600 and 1200 r may be due to a limited intake of food, and that the less pronounced fall and greater rise in the values in the later period can be ascribed to the stress acting to compensate the glycogen level. (BBB)

3513 INACTIVATION OF THE RADIATION-RESISTANT SPOILAGE BACTERIUM MICROCOCCUS RADIODURANS. I. RADIATION INACTIVATION RATES IN THREE MEAT SUBSTRATES AND IN BUFFER. D. E. Duggan, A. W. Anderson, and P. R. Elliker (Oregon State Univ., Corvallis). Appl. Microbiol., 11: 398-403(Sept. 1963).

A simplified technique permitting the pipetting of raw puréed meats for quantitative bacteriological study is described for use in determining survival of non-sporing bacteria, which are exceptionally resistant to radiation. Survival curves, using gamma radiation as the sterilizing agent, were determined in raw beef with four strains of Micrococcus radiodurans. Survival curves of the R_1 strain in other meat substrates showed that survival was significantly greater in raw beef and raw chicken than in raw fish or in cooked beef. Resistance was lowest in the buffer. Cells grown in broth (an artificial growth medium) and resuspended in beef did not differ in resistance from cells that had been grown and irradiated in beef. Survival rate was statistically independent of the initial cell concentration, even though there appeared to be a correlation between lower death rate and lower initial cell concentrations. The initial viable count of this culture of the domesticated R_1 strain in beef was reduced by a factor of about 10^{-5} by 3.0 megarad, and 4.0 megarad reduced the initial count by a factor of more than 10^{-9}. Data suggest that M. radiodurans R_1 is more resistant to radiation than spore-forming spoilage bacteria. (auth)

3514 INACTIVATION OF THE RADIATION-RESISTANT SPOILAGE BACTERIUM MICROCOCCUS RADIODURANS. II. RADIATION INACTIVATION RATES AS INFLUENCED BY MENSTRUUM TEMPERATURE, PRE-IRRADIATION HEAT TREATMENT, AND CERTAIN RE-

DUCING AGENTS. D. E. Duggan, A. W. Anderson, and P. R. Elliker (Oregon State Univ., Corvallis). Appl. Microbiol., 11: 413-17(Sept. 1963).

The R_1 strain of Micrococcus radiodurans, previously determined to be more resistant than three other strains exposed to gamma radiation, was studied to determine the influence of certain environmental factors on resistance to radiation inactivation. The frozen state offered insignificant protection to the organisms irradiated in raw puréed beef. Resistance was reduced by higher menstruum temperatures (40 and 50°C) during irradiation. Pre-irradiation heat treatment was found to lower resistance to subsequent irradiation. When the cells were irradiated in buffer at pH 5, 7, or 9, no differences in resistance were noted. Cell suspensions in buffer were protected to some extent by cysteine but not by thioglycolate. Ascorbate enhanced radiation inactivation. (auth)

3515 INTESTINAL COMPLICATIONS FOLLOWING IRRADIATION FOR GYNECOLOGIC CANCER. David G. Ashbaugh and J. Cuthbert Owens (Univ. of Colorado, Denver). Arch. Surg., 87: 100-7(July 1963).

Intestinal injury following irradiation for gynecologic cancer is discussed with reference to 49 cases. These cases could be divided into three groups on the basis of the severity of the damage: group I, (8 cases), those with mild injury and little or no residual damage and symptoms; group II (9 cases), those with moderate injury and some permanent changes with or without symptoms; and group III (32 cases), those with severe injury who were incapacitated or required surgery. Group III includes seven patients who were cured of their malignancies but who died of the complications of radiation injury and the subsequent attempts to correct this damage. In group I the symptoms consisted mainly of rectal pain, diarrhea, tenesmus, and constipation, and in two instances, mild rectal stricture. All patients became asymptomatic with nonoperative management. In group II the initial symptoms were also pain, diarrhea, constipation, tenesmus, and rectal bleeding, persistent in varying degrees. Five patients developed stricture or narrowing of the rectum and sigmoid, but none required operation. In group III there were 19 bowel strictures and 32 fistulas, and 84 operations were performed in attempts to correct these problems. In the seven patients who died from complications of radiation therapy no tumor was found at postmortem examination. A review of other reports shows an incidence of intestinal complications following pelvic irradiation ranging from 2.4% to 17%, with one estimate as high as 50 to 75%. The problem here was not an overdosage of radiation, but the necessity in treating carcinoma, the primary aim of which is eradication of the malignancy, in using adequate dosage. It is suggested that with prompt recognition and early, vigorous treatment, many of the more severe cases could probably have been greatly modified. Treatment is generally nonoperative in the acute stage, which is best managed by supportive measures and the cessation of radiation therapy. The chronic stage frequently requires operative intervention for the relief of stricture or fistula, and an initial diverting colostomy is the operation of choice. Subsequently, additional procedures may be performed, but these sometimes lead to increased morbidity and even mortality. (BBB)

3516 EFFECT OF IONIZING RADIATION ON MAN AND HIS ENVIRONMENT. Atomics, 16: No. 6, 16-22 (Nov.-Dec. 1963).

The importance of ionizing radiation in the life of man is one of degree rather than time, for ionizing radiation has always been a part of man's environment. Sources of background radiation and geographical factors that influence its levels are considered. Results of interaction of radiations with living tissue, types of radiation, and knowledge of radiation effects are reviewed. Units of radiation measurement are defined. (H.M.G.)

3517 "GLUCOSE 6-PHOSPHATE-DEHYDROGENASE" ACTIVITY AND THIOL CONTENT OF THYMUS NUCLEI FROM CONTROL AND X-IRRADIATED RATS. Helen Deakin, Margery G. Ord, and L. A. Stocken (Univ., Oxford). Biochem. J., 89: 296-304(Nov. 1963).

A study was made of the thiol groups present in nuclei from rat thymus gland. Of the total thiol content of the nuclei, 70% was associated with arginine-rich histones. Proteins, including those containing thiol groups, are lost from nuclei isolated in ionic medium. Nuclei isolated in sucrose medium [sucrose (0.25M), calcium chloride (5 mM), and tris (5 mM), at pH 7.2] retain reproducible amounts of thiol compounds and "glucose 6-phosphate dehydrogenase." The reactivity of thiol groups in nuclei isolated in sucrose medium is increased if the final suspension is made in ionic medium. "[1-^{14}C]-N-Ethylmaleimide" was used in conjunction with radioautography to investigate the distribution of thiol groups in the nuclear population from rat thymus. X-irradiation in vivo or in vitro decreases the concentration of thiol groups in nuclei isolated in sucrose medium; this effect is transient if the glutathione reductase, present in the nuceli, is not inhibited by 10 μM– Zn^{2+} ion. X-irradiation in vivo increases the number of reactive thiol groups especially in nuclei from small thymocytes; this effect is most obvious in nuclei isolated in ionic medium where the inhibitory action of x-irradiation on nuclear thiol groups is not detected. Linoleic acid peroxide, in concentrations approximately equimolar to the thiol concentration, decreased the thiol content of the nuclei. (auth)

3518 RADIATION-INDUCED ACUTE SEBORRHEIC MANIFESTATIONS AFTER RADIOTHERAPY FOR BASOCELLULAR EPITHELIOMA. CURE WITH ANTIBIOTICS. R. Degos, J. Duverne, and Ch. Picot. Bull. Soc. Franc. Dermatol. Syphilig., 68: 225-7(Apr.-May 1961). (In French)

An unusual case of radiodermatitis in a 58-yr-old woman operated on for basocellular epithelioma of the inner aspect of the right eyelid is described. Postoperative radiation treatment was given as follows: 2000-r doses of unfiltered 50-kv x rays, three times, one week apart, for a total of 6000 r. After 15 days, slight ulceration of the irradiated portion and marked dermatitis of the surrounding skin area were noted. Local application of solution and ointments provided analgesia but did not cure the condition, which spread from the cheek to nose and chin, and was accompanied by seborrhea, over a period of 16 months. Bacterial examination revealed staphylococci, which promptly responded to antibiotic (erythromycin) treatment. A similarity was noted between this patient's condition and the more common reactions of children to scalp radiation treatment for ringworm. Other cases are cited to show occasional unusual side-effects of radiation treatment, and the possibility that the present case represents a unique type of skin response to radiation is discussed. Allergy alone, it is contended, probably does not explain the reaction observed, but a bacterial infection was involved in the reaction. It is concluded that this case and the two others mentioned indicate that other factors are of importance, the nature of which needs to be determined by further study. (BBB)

3519 RADIATION-INDUCED STERILITY IN THE INSECT RHODNIUS PROLIXUS. W. F. Baldwin and Evelyn L.

Shaver (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Zool., 41: 637-48(May 1963).

Doses of 2 Mvp x rays required to induce sterility in males and females in the fifth nymphal and adult stages were determined, as well as the effects of different ratios of sterile to fertile males in the viability of eggs. It was found that in the males, exposure of nymphs to 500 to 1000 r did not affect the hatching of eggs, but at higher doses sterility in the males reduced the hatch until complete sterility occurred at 4000 r. Some recovery from the sterilizing doses occurred at certain doses in the males, since the percentage hatch from groups irradiated at 1500, 2000, and 2500 r increased in the second and third months. In contrast, egg eclosion from females irradiated in the fifth instar stage was substantially reduced by 1000 r, and almost completely inhibited at 2000 r. Normal females mated to males irradiated at doses from 3000 to 4000 r produced comparatively few eggs during the first month, which was shown to be accountable by the fact that irradiation at doses that induce sterility during the fifth instar seriously impairs mating. Doses required to sterilize both sexes were much greater for adults than those required in the fifth instar stage. The percentage hatch from matings with irradiated males decreases from the 80 or 90% level in controls to zero at about 17500 r. In females, total sterility occurred at 8000 r. Laboratory population tests indicated that addition of a preponderance of sterile adult males significantly decreased the number of viable eggs. Different ratios of irradiated (17500 r) male adult insects and untreated males (10:0, 9:1, 8:2, etc.) were held with a constant number of normal females (10) for a 3-month period. For the first month, at least, a ratio of 9:1 or 8:2 sterile/fertile males substantially reduced the percentage eclosion of eggs from normal females. The effect disappeared at ratios of 4:6 and higher, where the percentage hatch reverted to normal levels. However, the viability of the eggs at all ratios of sterile:fertile males reverted to normal levels during the second and third months. In populations to which irradiated males were added, early death of these males removed their inhibitory effect on population growth; the death of males exposed to 17500 r in the early part of the adult stage eliminated them by the end of nine weeks. It is concluded that damage resulting from irradiation during the fifth instar precludes the use of insects exposed as immature nymphs for tests of the effects of sterile males on Rhodnius populations. (BBB)

3520 SOLID STEM: A RADIATION INDUCED MUTATION IN TRITICUM DURUM DESF. Alessandro Bozzini and Silvana Avanzi (CNEN, Rome). Caryologia, 15: 525-35 (1962). (RT/BIO(63)35)

Data are presented on the inheritance and culm anatomy of a solid stem mutant, induced in durum wheat Cappelli by x irradiation. F_1 plants of the cross between the mutant and the mother line Cappelli had intermediate phenotype. Genetic analysis of F_2 was particularly complicated as, in addition to parental types, many intermediate phenotypes were present. Completely hollow-stemmed plants reached 23.1% of the whole population, while the remaining individuals had at least the top internode below the spike filled with pith (3:1 segregation: $0.5 > P > 0.3$). Two hypothesis might be considered to explain the data obtained, namely: x-irradiation induced a semidominant mutation; and x-irradiation neutralized the action of a gene for hollow stem; epistatic, only when homozygous, on one or more genes inducing stem solidness. Considering the cytogenetical information on solid stem in the genus triticum, the second hypothesis seems most probable. A statistical analysis was carried on two anatomical parameters, namely: number of vascular bundles in the stem cross section and ratio between sclerenchymatic and total surface, both taken at the middle of each of the five uppermost internodes. The mean number of vascular bundles in the F_1 and in the mutant differed sifnigicantly from that of Cappelli. On the contrary, no significant differences were found in the mean ratios of sclerenchymatic to total stem area in Cappelli, the mutant, and their F_1. (auth)

3521 EFFECT OF IONIZING RADIATION ON HIGH-ENERGY PHOSPHATE LEVELS. Blahoslav Zicha (Veterinarni Vyzkumne Stredisko, Prague). Casopis Lekaru Ceskych, 101: 1284-91(Oct. 26, 1962). (In Czech)

Adenosine triphosphate, diphosphate, and monophosphate (ATP, ADP, AMP) contents and aldolase activity were determined in the tissues of Wistar rats subjected to whole-body, 800-r doses of 180-kv x rays given at a rate of 15 r/min. Assays were made in red cells, muscle, and liver tissue after 24 hr, 5 days, and 12 days. A disturbance of the energy metabolism was present 24 hr postirradiation. In liver, ATP, ADP, and AMP fell markedly, to $\frac{1}{4}-\frac{1}{3}$ the control levels; in erythrocytes ADP and AMP levels were maintained as ATP dropped ~15%; in muscle ATP fell slightly as ADP rose and AMP fell precipitously to negligible concentrations. Aldolase activity declined to very low levels in red cells, less markedly in liver and muscle; in muscle it underwent a late rise to above control levels. The values for ATP, ADP, and AMP suggest a differential sensitivity of irradiated tissue. From the decline of aldolase, impaired glycolysis is evident. Most marked changes were observed in liver where repair processes were still absent on the 5th and 12th day after irradiation. In muscle the initial decline of phosphate esters and aldolase activity observed 24 hr after irradiation was followed by an increased activity with a raised ATP and ADP content and a higher aldolase activity. Changes in red cells 24 hr after irradiation were not marked, but progressively increased with time. (BBB)

3522 EFFECT OF X-RAYS ON THE FORMATION OF OXIDATION PRODUCTS IN LIPIDS OF CERTAIN RAT ORGANS. K. Lejsek. Cesk. Fysiol., No. 1, 67(1963).

The formation of oxidation products in lipids was investigated in liver, kidney, brain, and spleen homogenates of rats exposed to a dose of 600 r, using the thiobarbituric acid test (TBA). Without incubation the TBA chromogen values of the homogenates of the exposed rats did not differ appreciably from those of the controls, only the brain homogenates showed considerably higher values. After incubation for one hour at +37°C the TBA chromogen of the homogenates of irradiated rats showed higher values than those of the controls incubated for one hour. (TCO)

3523 EFFECT OF 2-β-AMINOETHYLISOTHIOUREA (AET) ON THE LESIONS OF CRYPT NUCLEI OF THE SMALL INTESTINE OF IRRADIATED MICE. J. R. Maisin, A. Leonard, and M. Lambiet (CEN, Mol, Belg.). Compt. Rend. Soc. Biol., 157: 1115-18(1963). (In French)

In order to study the effect of AET on the lesions of crypt nuclei of the small intestine, male C^+ mice, aged 3 months, were exposed to x-ray doses of 225, 450, 900, and 1350 r. The mice were sacrificed at various intervals after the irradiation. The results show that some of the cytological lesions occurring after irradiation (fragments and bridges of cellules in anaphasis, lowering of the mitotic activity) are, even after 225 r, directly visible in the crypt nuclei of intestinal cells; other modifications (pyknosis and augmentation of nuclear surfaces) appear only after an hour and longer after irradiation. The degree of protection

offered by AET to intestinal crypt cells is the same for all x-ray doses used. As the lesions, during the first few hours after irradiation, are less marked in the protected mice than in the unprotected mice, it is suggested that AET acts principally by protecting the nuclei of crypt cells against certain lesions caused by irradiation and not by facilitating selectively regeneration processes. AET seems to protect the nuclei during the complete mitotic cycle. (J.S.R.)

3524 EFFECT OF X RAYS ON THE SURVIVAL AND THE GROWTH OF YOUNG RATS IRRADIATED 8 OR 17 DAYS AFTER BIRTH. A Leonard and J. R. Maisin (CEN, Mol, Belg.). Compt. Rend. Soc. Biol., 157: 1119-22(1963). (In French)

A study of the effect of x rays on the survival and growth of young rats showed that the growth of rats whole-body irradiated at the age of 8 or 17 days is slowed only after x-ray doses of at least 300 r. The weight loss of the testicles is strongly affected even after very low doses. This weight decrease, which is less pronounced in individuals protected with AET than in nonprotected mice, depends on the irradiation dose and the age. The kidneys of young rats are more radiosensitive than those of adult rats (105 mortality less than 6 months after irradiation as a result of nephritis in the irradiated rats. (tr-auth)

3525 STUDY OF THE PROTEIC MODIFICATIONS OF THE SERUM OF THE RAT AFTER WHOLE-BODY IRRADIATION. A. Sassen, F. Kennes, and J. R. Maisin (CEN, Mol, Belg.). Compt. Rend. Soc. Biol., 157: 1122-6(1963). (In French)

The techniques of microelectrophoresis in glucose and immunoelectrophoresis were used to study the effects of irradiation on the serum proteins of the rat. Wistar rats were exposed to x-ray doses of 750, 1000, and 1100 r, and blood samples were taken at 4-day intervals after the irradiation. After irradiation the serum proteins show quantitative modifications. Prealbumin and γ-globulin are sharply decreased. The other globulins, expecially α_1 and β_1, are strongly increased only after a lethal dose. From a qualitative point of view, slight changes in the immunoelectrophoretic picture appear 24 hr. after irradiation and then accentuate. (J.S.R.)

3526 HEMATOPOIETIC IRRADIATION DAMAGE IN MEDICAL PERSONNEL IN BULGARIA. D. G. Zographov (Sofia Medical School). Deut. Gesundheitsw., 16: 1068-71 (June 8, 1961). (In German)

Hematologic tests were given to 1478 persons occupationally exposed to radiation and to 850 control subjects. Among the experimental group, 7.5% more showed quantitative changes in the blood picture as compared with the controls. All the hematologic differences that were measured in x-ray personnel and control group were statistically significant. The frequency of radioinduced changes was found to be independent of the number of years spent in radiology. There was also a difference in frequency of hematologic changes in the experimental vs the control group taken from other fields of medicine, but these differences were of borderline statistical significance. It was estimated that in 1957, 6.9% of all medical personnel received a daily dose of >50 mr. In 1960, 21% of the personnel received a weekly dose of over 100 mr. It was shown that the daily dose of 50 mr caused hematopoietic depression in every case examined, but out of the 21% of the personnel receiving >100 mr weekly doses, only 7.5% showed evidence of serious bone-marrow radiation injury. (BBB)

3527 INFLUENCE OF A PHYSICAL BURDEN AND MANDIBULAR INJURY ON THE SURVIVAL OF IRRADIATED ANIMALS. Vladimir Sicha (Stomatological Clinic of the Medical Faculty, Hradec Kralove, Czechoslovakia). Deut. Zahnaerztl. Z., 17: 1029-33(1962). (In German)

The combined effects of jaw fracture, x radiation, and physical exertion (swimming) with and without added weight were measured in rats (175 to 190 g). The added weight was 10% of the body weight. Animals irradiated with a single dose of 400 to 600 r either immediately or 5 hr after penetrating jaw fracture survived for periods up to two weeks. Of animals with jaw fracture but exposed once to only 400 r, 25% survived for more than 30 days. Animals that either were forced to swim twice for 3 to 3½ hr each 24 hr, received 450 r, swam with jaw fracture, or swam and then received 450 r; all survived for more than 30 days. Only 20% survived from groups that received 450 r after jaw fracture or 450 r after jaw fracture and swimming combined. Jaw fracture plus swimming gave 100% survival, but if 450 r was given after swimming, without jaw fracture, only 87.5% survived for 30 days. Single administration of 450 r followed by jaw fracture and swimming reduced average survival to about 12 days. None survived for 30 days. Swimming with added weight plus jaw fracture resulted in 80% survival, but when this type of swimming was followed by 450 r, only 60% survived. No animals survived the combination of burdened swimming, 450 r, and fractured jaw longer than 12 days. Swimming without added burden, 450 r, and jaw fracture together resulted in only 20% survival for 30 days, but none survived longer than two weeks if the exercise and jaw fracture followed the irradiation. Overexertion after sublethal doses of radiation generally increased mortality more than if the physical exertion took place prior to the irradiation. (BBB)

3528 EFFECT OF X-RAYS ON THE CONCENTRATION OF PHOSPHORUS COMPOUNDS IN THE SYMMETRICAL SECTIONS OF THE CEREBRAL HEMISPHERES OF RABBITS. I. A. Medyanik and G. K. Starostyuk. Dopovidi L'vivs'k. Derzh. Univ., [No. 9], Pt. 2, 105-6(1961).

A single irradiation of rabbit's head (intensity and duration not indicated) lowered the content of phospholipids and deoxyribonucleic acid. The content of acid-soluble and inorganic P decreased, and ribonucleic acid slightly increased. The acid-soluble and inorganic P gradually diminished during the first 14 days after irradiation. Beginning with the 15th and continuing to the 28th day after irradiation, the content of P compounds rose in the symmetrical cerebral section, without reaching normal levels. Daily brain anodization (5 ma. for 15 min.) brought the content of the P compounds to their normal levels. Under similar conditions the cathode of direct current enhanced the disturbance in the P compound content. (Ref. b Zh., Biol. Khim.)

3529 EFFECT OF X-IRRADIATION ON THE NEUROSECRETORY SYSTEM. V. F. Maiorova (Inst. of Experimental Endocrinology, Moscow). Federation Proc., Transl. Suppl., 22: T1187-90(Nov.-Dec. 1963).

Exposure of rats to minimal lethal doses of whole-body x irradiation causes changes in the secretory function of the nerve cells of the hypothalamus. During the first few hours after irradiation, there is intensification of the synthesis, and of the release into the blood, of the neurosecretory substance elaborated by the neurons of the supraoptic and paraventricular nuclei. Twenty-four hours after irradiation, the neurosecretory activity of the hypothalamo-hypophyseal system has returned to normal. A comparison of the alterations in the neurosecretory activity of the hypothalamo-hypophyseal system with the coincident changes in the blood ACTH levels gives reason to assume

an interrelationship between the neurosecretion of this system and the adrenal corticotropic function of the adenohypophysis. Evidently, the hypothalamo-hypophyseal system responds to the absence of pituitary ACTH by increased neurosecretory activity. (auth)

3530 VACCINATION OF MONKEYS AGAINST GAS GANGRENE CAUSED BY Cl. PERFRINGENS UNDER CONDITIONS OF CHRONIC IRRADIATION. E. K. Dzhikidze and A. S. Aksenova (Inst. of Experimental Pathology and Therapy, Academy of Medical Sciences, USSR). Federation Proc., Transl. Suppl., 22: T1207-9(Nov.-Dec. 1963).

Prolonged irradiation of monkeys with a total dose of up to 519 r did not increase the sensitivity of the organism to gas gangrene (Cl. perfringens). Prophylactic vaccination during chronic irradiation was effective, producing active immunity of high intensity and preventing the death of animals infected with three to six lethal doses of Cl. perfringens. (auth)

3531 CROSS-RESISTANCE OF ESCHERICHIA COLI B TO PENICILLIN AND IONIZING RADIATION. Vera Kutas-Mannhardt (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Intern. J. Radiation Biol., 6: 513-21 (June 1963).

The radiosensitivity of cultures resistant to 1500 IU/ml, 2000 IU/ml, 2500 IU/ml of penicillin, produced from strain E. coli B was examined. Cultures in the log-phase were streaked in monocellular layers on the agar surface and exposed to x irradiation. As a result of penicillin treatment cell-filaments consisting of several segments were formed. Measurement of viability of x-irradiated cultures proved that penicillin resistant cultures are considerably more radioresistant than the parent strain B, non-treated with penicillin. (auth)

3532 OBSERVATIONS ON RHYTHMICAL-POTENTIAL DIFFERENCE FLUCTUATIONS IN ONION-ROOTS AND THE RADIOSENSITIVITY OF THIS REACTION. Matts Helde (Universität, Freiburg i. B and Karolinska Inst., Stockholm). Intern. J. Radiation Biol., 6: 523-7(June 1963).

A sine periodical voltage change between the root tip and any reference point of the root was studied in Allium cepa. The amplitude is some millivolts, and the period of the order of 15 minutes. The voltage-time-curves are registered automatically. Unpolarizable electrodes are used and connected to the root via tap water in special electrode vessels. Gassing the water of apical electrode with oxygen or nitrogen, there appear small, characteristic disturbances of the curves but no changes of their general shape. Extremely small quanities of carbon monoxide, however, instantaneously bring the swinging system to a standstill for hours. This suggests that the oscillating system is connected with cellular respiration, and that some enzymatic step herein may be a key reaction. The oscillations studied are disturbed by ionizing radiation. Under hyperoxia some few rads gamma- or x-rays at the root tip can bring the system to a standstill for some minutes; about 10 rads gamma-radiation given for 30 sec can result in a complete deletion of a full period. These low dose reactions are reversible and follow mostly in a few seconds after the irradiation. Irradiations under anoxia produce no or very small changes at these doses. (auth)

3533 STUDIES ON THE RADIOSENSITIVITY OF MONONUCLEAR INFLAMMATORY CELLS, IN VITRO. V. Várterész, G. J. Koeteles, F. Antoni, and L. D. Szabó (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Intern. J. Radiation Biol., 6: 541-7 (June 1963).

Mononuclear cells were irradiated in vitro with different doses of x rays. RNA-labeling with P^{32} was studied. After irradiation (5000–10000 r) there was a decrease of specific activity in the total RNA as compared with the control cells. This initial effect of x rays on RNA-labeling proved to be reversible after a few hours (2–3) after irradiation. The RNA specific activity of irradiated cells was studied in the phenol-released fraction, in that remaining in the phenol phase and in the different fractions of RNA separated on ECTEOLA. The initial decrease of specific activity was demonstrated in all fractions. Under such circumstances the immediate effect of x-ray on RNA-labeling is questionable. (auth)

3534 RADIOSENSITIVITY AND BIOLOGICAL PROPERTIES OF TWO TUMOUR-TYPES INDIGENOUS TO THE SAME HOST. VI. THE EFFECTS OF X-IRRADIATION ON SUBCELLULAR UNITS. Anna Goldfeder and Leo A. Miller (Department of Hospitals, New York and New York Univ., New York). Intern. J. Radiation Biol., 6: 575-607 (June 1963).

Studies have been carried out on effects of x-radiation on intracellular fine structures and on ATPase activity of cell nuclei and of mitochondria. Two types of mouse mammary tumors—epithelial, designated H, and spindle-cell, designated G, both indigenous to the inbred DBA/212 strain of mice—served as the basic test material. Mouse lymph-nodes were used for control tissue. The tissues were irradiated in situ with various doses of 200 kv, filtered x rays and excised at various time-intervals after irradiation for analytical and cytological studies. Ultra-centrifugation procedures were used for isolation of sub-cellular units, and electron microscopy for identification of cellular ultrastructures. A significant, quantitative difference in the inherent mitochondrial and nuclear ATPase activities of these two types of tumor was noted. The inherent mitochondrial ATPase of the epithelial tumor was 62 per cent higher than that of the spindle-cell tumor. This difference is explained by the greater number and better quality of the mitochondria of the epithelial tumor, compared with those of the spindle-cell tumor, as revealed electron-microscopically. Conversely, the non-irradiated nuclear ATPase activity of the spindle-cell tumor was 20 per cent greater than that of the epithelial tumor. This difference was explained by the larger size of the spindle-cell tumor-nuclei. The effects of x irradiation on nuclear and mitochondrial ATPase activity of both types of tumor are shown. Electron-microscopic studies revealed profound changes in the sub-cellular units of the irradiated tumor cells, such as swelling of mitochondria, ruptures of their limiting and internal membranes (cristae), dilatation of the vesicles of the endoplasmic reticulum, ruptures of the plasma membranes and aggregation of the ribonucleoprotein (RNP) particles. These phenomena were more prevalent in the spindle-cell tumor after irradiation with 3000 than in the epithelial after 5000 rads. Similar manifestations, but more dramatic and to a greater extent, were produced in the cells of the lymph-nodes after irradiation with relatively small doses (400 rads). Whereas the earliest profound changes induced by x irradiation were noted in the sub-cellular units of the cytoplasma, no apparent changes were noted in the interphase nuclei. The plasma cells which are characterized as rich in vesicles of the endoplasmic reticulum and poor in mitochondria proved to be the most radiosensitive. (auth)

3535 POSTIRRADIATION FRACTURES OF THE FEMORAL NECK. Alan H. Goodman (Navy Submarine Base, Groton, Conn.) and Mary S. Sherman. J. Bone Joint Surg., 45A: 723-31(June 1963).

Histopathologic studies were made on bone biopsies obtained from six patients operated on for postirradiation fractures of the femoral neck. Total doses of radiation (Ra and x ray) varied from 2000 to 6000 r. These specimens demonstrated only two consistent and pertinent findings: the bone was uniformly viable, extensive marrow fibrosis and edema were present. Two patients exhibited osteoporosis, but this finding is not unusual in older patients and therefore difficult to evaluate. Similarly, the observed focal necrosis in the calcar femoral and degenerative articular changes may be age-connected. Some blood vessels showed narrowing by subintimal fibrosis, but this was not a constant phenomenon. Disorganized, hypercalcified bone was seen in two patients and is difficult to explain. It is similar to bone seen in patients poisoned with Ra and to the tumor bone of osteogenic sarcoma. In all three conditions, the peculiar staining characteristics and appearance of this bone were most likely expressions of a profound alteration of bone structure. It was concluded that although the therapeutic doses employed for irradiation of pelvic malignant tumors are insufficient to produce necrosis of the femoral head, they do alter the bone sufficiently to permit pathologic fracture. Events leading to such fracture may depend on changes in the metabolism of bone not reflected in its microscopic structure. It is probable that the ability of the various cells of the femoral head and neck to maintain a healthy structure is temporarily upset by therapeutic pelvic irradiation. Total necrosis does not occur with these doses, but alterations of cellular function probably does occur, perhaps with the elaboration of abnormal matrix. It is possible that the mineral components may also be altered. Such a sequence of events could produce a structurally weak interface between normal bone and that altered by the irradiation. This condition predisposes to a pathological fracture by usual stresses. Since the bone is not necrotic and the cells are apparently able to recover, these fractures often heal readily and do not recur. (BBB)

3536 THE BIOLOGICAL REACTION TO IONIZING RADIATIONS. ATOMIC STRUCTURE. Thad P. Sears (Veterans Administration Hospital, Denver). J. Periodontol., 34: 174-82(Mar. 1963).

Basic principles of nuclear physics are surveyed in relation to biological and medical aspects of ionizing radiation. A discussion is presented of the following theories of biological injury: the theory of point heat, the radiochemical theory, colloid chemical theory, physiochemical theory, disruption of tissue molecules by breakage of valence bonds, and theory of chromosomal injury. The irradiation syndromes are discussed, including: radiation sickness, the neurological syndrome, the gastroenteric syndrome, and the bone marrow syndrome. It is concluded that definitive data on biological injury, genetic mutations, maximum permissible exposure, and the chronic effects of radioactive fallout are not sufficiently established at this time to justify the apprehensive state now prevalent in America regarding radiation hazards. (BBB)

3537 THE COMBINED EFFECTS OF ROENTGEN AND ULTRAVIOLET IRRADIATION ON THE THROMBOCYTE COUNT IN MICE. Istvan Cserhati, Ferenc Krizsa, and Kalman Rak (Orvostudományi Egyetem, Szeged). Kiserl. Orvostud., 13: 135-7(May 1961). (In Hungarian)

Mice weighing 20 g were exposed to a Hanau quartz lamp at a distance of 0.5 m for 30 min and to an x irradiation dose of 300 r. To investigate the possible development of a humoral factor affecting thrombocytes, 0.2 ml of serum of doubly irradiated mice was injected into the tail veins of recipient animals. At 60-min post-uv treatment the thrombocyte count fell 40%, then rose to 55% above normal at 24 hr and dropped to 10% above normal at 48 hr. Three groups of mice were irradiated. The control group received no protection and its thrombocyte count fell to 60.8% below normal on the 10th day postirradiation. The second group received uv treatment 24 hr prior to irradiation, and showed a 21% elevation in thrombocyte count at 10 days. If the uv treatment took place 24 hr postirradiation there was no marked change in thrombocyte count; a 10% drop below normal was noted. When serum obtained 24 hr post-uv treatment was injected into recipients 24 hr postirradiation, thrombocytopenia did not develop, but serum given on the 5th day did not prevent thrombocytopenia. It is concluded that uv treatment prior to roentgen irradiation, or serum given at the appropriate time from pretreated animals offers effective protection against x-radiation-induced thrombocytopenia. (BBB)

3538 A CURRENT STUDY OF RADIATION GENETICS IN MONKEYS. Shou-yuan Chao and Chung-shu Chang. K'o Hsueh T'ung Pao, No. 3, 19-22(1963).

The importance of using monkeys instead of rodents in radiation genetics studies is discussed. (P.C.H.)

3539 THE EFFECTS OF GAMMA IRRADIATION ON THE RHEOLOGICAL PROPERTIES OF WHEAT GLUTEN. Masao Doguchi, Yoshiharu Yokoyama, and Ikunosuke Odaka (Tokyo Labs. for Medical Science). Kogyo Kagaku Zasshi, 66: 718-20(May 1963). (In Japanese)

Wheat gluten samples were x irradiated at doses from 4×10^5 to 10^7 rep, and the flours, prepared by mixing the gluten samples with wheat starch, were subjected to rheological tests. The apparent viscosities obtained by the McMichael viscometer and the maximum viscosity of the alkaline viscogram tended to decrease with increasing dosage. Farinograms and mixograms, obtained by the constant water absorption method, showed that the dough development curves changed their shape after irradiation; for example, the maximum resistance to mixing and the time to reach this maximum decreased. When the dosage was increased to more than 3×10^6 rep, the samples lost the unique elastic and cohesive properties of wheat gluten. Moreover, as the irradiation dose increased, the extensigrams showed a notable decrease in resistance and a slight decrease in extensibility; such changes were not observed after treatment with either sulfhydryl-blocking reagents or by disulfide bond-splitting reagents. Gluten was so denatured at 10^7 rep that a dough could not be prepared from the sample. These results show that the changes of the rheological properties of wheat gluten induced by x irradiation are due to a structural change of the protein molecule of gluten rather than the breaking of disulfide bonds or blocking of sulfhydryl groups. (BBB)

3540 EFFECT OF RADIOACTIVE PHOSPHORUS ON THE GROWTH AND DEVELOPMENT OF ALBINO AND GREEN SUNFLOWER PLANTS. Yu. D. Beletskii. Materialy 3-ei [Tret'ei] Nauchn. Konf. Aspirantov Rostovsk. Univ., Rostov-on-Don, Sb., 1961, 309-12.

Albino sunflower plants absorbed P^{32} more energetically than did green sunflower plants. P^{32} in doses of 3 and 4.5 mc. sharply depressed the growth and development of the albino plants; 3 mc. of P^{32} stimulated the growth of green sunflower plants, and 4.5 and 6 mc. inhibited their growth. (Ref. Zh., Biol. Khim.)

3541 BLOOD CHANGES UNDER THE EFFECT OF PROLONGED REPEATED X-RAY IRRADIATIONS. A. B. Rusakov and Z. Ya. Vainer. Med. Radiol., 8: No. 10, 50-2(Oct. 1963). (In Russian)

Following observations of 60 rabbits subjected to a fractional low-dose x irrradiation, evidence was made available showing changes in the blood of the animals to grow progressively with the increased summary radiation dose. The return of the blood to its normal level occurred in animals given a dose of 1200 r on the 25–30th day, and in those that received a dose of 2000 r–by the end of the 2nd month after irradiation. (auth)

3542 DEMONSTRATION OF X-RAY EFFECTS ON THE SECONDARY STRUCTURE OF META HEMOGLOBIN. J. Krumbiegel. Monatsber. Deut. Akad. Wiss. Berlin, 5: 476-82(1963).

An apparatus is described with which the rotational dispersion of dyed proteins can be measured in the wavelength range from 250 to 1100 manometers. The results obtained for horse and human meta hemoglobin are presented in graphical form. (OTS)

3543 EFFECTS OF n-BUTYL METHANESULPHONATE AND RELATED MUTAGENS ON BARLEY. Edith E. Froese-Gertzen, R. A. Nilan, C. F. Konzak, and R. R. Legault (Washington State Univ., Pullman). Nature, 200: 714-15(Nov. 16, 1963).

The mutagenic effects of n-butyl methanesulfonate (n-BMS), isobutyl methanesulfonate (isoBMS), n-propyl methanesulfonate (nPMS), methyl methanesulfonate (MMS), isopropyl methanesulfonate (isoPMS), and ethyl methanesulfonate (EMS) on barley are reported. The results showed that all the sulfonates except isoBMS induced chlorophyll-deficient mutations. In all cases, the mutations were induced by treatments that produced low rates of damage to seedling growth and plant survival and to chromosome structure. It is expected that a treatment adjusted to the slow reactivity of isoBMS will also induce and increase mutation rate. Data obtained from barley seeds (14% moisture content) exposed to 30 kr of x rays at room temperature show that the induction of mutation in 8% of the spikes is associated with chromosome aberrations of 53 bridges and 309 fragments per 100 cells. This level of injury to chromosome structure, as well as to seedling growth and plant survival in relation to the amount of induced mutation, demonstrates the lower mutagenic efficiency of radiation compared with that of most chemical mutagens investigated. (P.C.H.)

3544 BONE MARROW TRANSPLANTATION IN CLINICAL CASES AND RELATED PROBLEMS, ESPECIALLY EVOLUTION OF TYPE O ERYTHROCYTES ORIGINATING FROM INFUSED BONE MARROW IN PERIPHERAL BLOOD OF RECIPIENTS. Kazuo Miyoshi and Akira Shirakami (Tokushima Univ., Japan). Nippon Ketsueki Gakkai Zasshi, 24: 672-81(Dec. 1961). (In Japanese)

Homologous bone marrow obtained from donors of the same ABO blood-group type or type O was infused intravenously into 22 patients with various diseases, including leukemia, aplastic anemia, granulocytopenia, and multiple metastatic cancer. As preliminary treatment, x rays or Co^{60} γ radiation (1000–15000 r) and cytostatic drugs were given to the cases with leukemia or carcinoma, and adrenocortical steroid hormone was also given in some cases. The number of infused bone marrow cells varied from 20 to 150×10^8, given in 1–6 times in each case. No specific side-effects were observed after these procedures. The cases were studied clinically and hematologically and the fatal cases pathologically. In those patients whose blood-group type was not O and who received bone marrow from O donors, the O type cells were found in peripheral blood by a differential agglutination method for days following the infusion of bone marrow. Changes in O type cell counts were studied comparatively in various recipients (those with radiation-destroyed marrow, pathologic marrow of hypoplastic type, and apparently normal marrow). Cell count-time curves were analyzed by comparison with hypothetical curves obtained by calculations based on the assumption that the marrow cells divided and matured in the body of recipients at a normal physiologic rate. The results revealed that O type cells in recipients with depleted marrow and pathologic marrow of hypoplastic type increased 1-3 weeks after the infusion of marrow and the increase continued 2-3 weeks thereafter and then decreased. The absolute number of the O type cells was $5\text{-}15 \times 10^4/mm^3$ when about 2×10^9 marrow cells were infused, i.e., the number of the O type cells corresponded to about 100 times the calculated number 1-2 weeks after the marrow infusion. In the blood of cases with normal marrow, O type cells showed no significant increase. The degree of temporary take of infused bone marrow could be evaluated directly by this method (O type bone marrow infusion). (BBB)

3545 EFFECT OF RADIATION ON RESPONSE TO ANESTHETIC AGENTS. Howard L. Zauder and Louis R. Orkin (Yeshiva Univ., New York). N. Y. State J. Med., 63: 1943-50(July 1, 1963).

An attempt was made to determine if prior irradiation modified the response to anesthesia or if any anesthetic or anesthetics are associated with an abnormally high or low mortality, following irradiation. Swiss mice were irradiated by a conventional radiotherapy machine utilizing 250-kv x rays with 1-mm aluminum and 0.5 mm copper filtration. The half-value layer was 1.5 mm of copper, and with a target-skin distance of 70 cm; the dose rate in air was 52 r/min. A dose-response curve, relating mortality at 30 days to the amount of radiation delivered gave an LD_5 of 350 r, LD_{25} of 450 r, and LD_{95} of 750 r. A chamber for the anesthetization of small animals with a known, reproducible concentration of anesthetic agent was designed providing for constant circulation of the gas mixtures, explosive or nonexplosive. Utilizing this apparatus, groups of mice were anesthetized with 6% divinyl ether, 6% diethyl ether, 1.5% halothane, 1.8% trichlorethylene, and 18% cyclopropane. With the latter, oxygen was added to the chamber in sufficient quantity to provide a concentration of 20 to 25%. Pentobarbital (Nembutal) 30 mg/kg, thiopental sodium (Pentothal) 70 mg/kg, or meperidine hydrochloride (Demerol) 25 mg/kg was injected intraperitoneally into mice with and without prior x radiation. There was no mortality associated with these dosages in the control animals. All drugs were administered to the irradiated animals on the 1st to 28th day postirradiation. In mice irradiated with an LD_5 (350 r) and anesthetized subsequently with divinyl ether, diethyl ether, or halothane, an increase in the mortality over control values was observed. This increase was greatest following divinyl ether; its administration 7 or more days following irradiation resulted in the death of 10 to 30% of the animals during the 45-min period of anesthetization. After 350 r, meperidine and pentobarbital did not increase mortality, but thiopental increased markedly the number of deaths when administered on the 2nd, 4th, or 21st day postirradiation. After 450 r the mortality rate was increased markedly, but cyclopropane was associated with the least increase. As with the volatile agents, mortality following the parenterally administered agents increased as the dose of radiation increased, but no difference was demonstrated between pentobarbital and its thio derivative. Sleeping time following both drugs was increased 3-fold over that in controls. The mortality following anesthesia in mice who received 750-r (LD_{95}) made

it impossible to anesthetize these animals beyond the 7th day postirradiation. Again, a significant number of deaths under anesthesia occurred with divinyl ether, and sleeping time following the barbiturates was prolonged, but not beyond the 3-fold increase which was seen at 450 r. It is concluded that divinyl ether is associated with the highest overall mortality and cyclopropane with the lowest; decreasing the concentration of diethyl ether decreases the mortality. The cause of the increased mortality is unknown, since gross and microscopic examinations of autopsy material failed to reveal any differences accounting for these results. (BBB)

3546 A CASE OF ACUTE LEUKEMIA AFTER A LARGE DOSE X IRRADIATION (SOME PROBLEMS OF RADIATION-INDUCED LEUKEMIA). Ferenc Szarvas and Kalman Raek (Medical Univ., Szeged). Orv. Hetilap, 102: 1128-30(1961). (In Hungarian)

The case is described of a 46-yr-old patient who entered the hospital complaining of weight loss, anorexia, and weakness. She related that a year earlier a hysterectomy was performed because of a malignant uterine growth. Subsequently, over a period of four months she had received therapeutic x-ray treatment, 60 fractionated doses totaling 12,000 r, over the lower abdomen. Laboratory tests revealed myeloid leukemia. She died 13 days after entering the hospital; an autopsy showed no primary tumor or metastases, but confirmed the cause of death as acute leukemia. It is suggested that the rising world-wide incidence of leukemia should concern public health authorities and that increasing exposure to ionizing radiation may be partially responsible. It is pointed out, for instance, that prenatal pelvic x-ray examinations of the mother occurs twice as frequently among children developing leukemia than among a control group. The frequency of leukemia is 10 times the normal rate among x-ray treated patients with anbylosing spondylitis, 9 times higher among radiologists, and 6 times higher among children treated for thymic hyperplasia. The type of leukemia most frequently allegedly induced by ionizing radiation is chronic or acute myeloid leukemia. The disease may occur after a few months to 10 yr following exposure, and most frequently between the 3rd and 5th yr. It is also questioned whether some new drugs which are not properly tested before marketing might not cause damage to the bone marrow and thereby increase the susceptibility to leukemia from radiation or other primary cause. (BBB)

3547 RADIATION-INDUCED RENAL INJURY. Policlinico (Rome), Sez. Prat., 68: 1016-20(July 3, 1961). (In Italian)

3548 EFFECTS OF ACETONE, ULTRAVIOLET IRRADIATION AND FORMALIN ON WEST NILE VIRUS INFECTIVITY AND IMMUNOFLUORESCENT ANTIGENICITY. W. D. Kundin and Chien Liu (Univ. of Kansas, Kansas City). Proc. Soc. Exptl. Biol. Med., 114: 359-60(Nov. 1963).

An effort was made to ascertain whether infectious virus in thin sections could be inactivated without destroying either the antigenicity of the virus or the integrity of the tissue. Adjacent sections of the head from a suckling mouse dying of the Egypt 101 strain WN virus infection were exposed for varying lengths of time to the atmosphere (in the dark), to ultraviolet light, and to acetone (analytic grade) at room temperature, or to 10% buffered formalin at 4°C. Infectivity of West Nile Virus in frozen sections was inactivated by UV light in a matter of minutes while antigenicity persisted for several hours. Immersion of infected frozen sections in acetone inactivated 99% of virus infectivity in minutes yet antigenicity was not impaired for up to two weeks at room temperature. In our hands fixation by formalin was found to be unsatisfactory. (auth)

3549 NEW CONCEPTS BEARING ON THE GENETIC AND CYTOLOGICAL EFFECTS OF RADIATION. Benedetto Nicoletti (Università, Rome). Riv. Biol., 56: 291-307(July-Sept. 1963).

The genetic and cytological effects of radiation are considered. The dose-rate effect, repair processes, and the relation of cell stage and radiation sensitivity are discussed. It was concluded that radiation damage results from complex interactions that are difficult to trace to one simple mechanism. (M.C.G.)

3550 EXAMINATION OF DIURNAL VARIATION IN LETHALLY IRRADIATED RATS. Robert L. Straube (Argonne National Lab., Ill.). Science, 142: 1062(Nov. 22, 1963).

In anesthetized white rats no significant diurnal variation in lethality of an x-ray dose that killed 100 percent of the rats in 30 days was found. (auth)

3551 ULTRAVIOLET RADIATION EFFECTS ON LOW MOLECULAR WEIGHT INORGANIC PHOSPHATES OF YEAST. E. M. Lieberman and P. A. Swenson (Univ. of Massachusetts, Amherst). Science, 142: 1315-16(Dec. 6, 1963).

Ultraviolet radiation caused the loss of ortho-, pyro-, tripoly-, tetrapoly-, and trimetaphosphate from yeast cells to the medium. Analyses of combined cell and medium phosphates showed a two-and-a-half-fold increase in pyrophosphate after irradiation while inorganic and total phosphate remained constant. (auth)

3552 LATENT DAMAGE BY X-RAYS TO DNA IN THE VITULAR THYMUS. Tsai-ping Li, Pei Ching, Hsin-fa Lu, and Hsiao-chen Chien. Shang-hai-shih K'o Hsueh Chi Shu Lun Wen Hsuan Chi, 1960, 87-100(1962).

Vitular thymus DNA solutions were prepared and then irradiated at a dosage of 1000 r/min. Viscosity drop was due to the degradation of large molecules 2 hours after irradiation. The relation of DNA degradation to radiation dosage indicated the behavior of DNA in the natural state. At 76°C DNA molecules became unstable and latent damage occurred in the structure. The ultraviolet absorption of DNA was unaffected after preservation of temperature at 76°C for 60 minutes. After irradiation and without temperature preservation, a slight increase in absorption was observed. A preservation of 76°C induced a remarkable increase in DNA ultraviolet absorption. Latent damage not only destroyed the H bond between the double helix molecules but also increased the unstability of H bonds. The failure of a large radiation dose to lower the viscosity in a great extent indicated that a protecting agent may be found in a DNA solution. The presence of a protecting agent enabled the DNA solution to withstand x radiation of 6×10^4 r without direct emergence of degradation. Latent damage may occur at a definite radiation dose. Investigation revealed that the protecting agent might be calcium citrate. Latent damage may be explained by: breaking of backbone chains on one side; part of H bonds destroyed; and increased unstability of residual H bonds. All three items show a parallel proportional relationship. (TCO)

3553 THE PROBLEMS OF PHOTOGRAPHIC DOSE MEASUREMENTS OF CONVENTIONAL AND ULTRA-HARD RADIATION. Hans Ludwig Keller (Universität, Erlangen-Nurenberg, Ger.). Strahlentherapie, 122: 174-8 (Oct. 1963). (In German)

Hardness factors for radiation of 70 Kv, 200 Kv, Co^{60}, and 17 Mev at the water surface and in different depths of a water phantom were determined by the use of blackening

curves. The results show a significant dependence of the hardness factors on water depth and field size. Theoretical considerations show that the film dosimetry of phantom measurements has certain minimum errors; e.g. up to ±16% for Co^{60} and phantom depths between 0 and 20 cm, and about ±27% for conventional radiation with a half value layer of about 1 mm Cu. (auth)

3554 HISTOCHEMICAL INVESTIGATION OF THE BEHAVIOR OF SOME ENZYMES IN THE HEART MUSCLE AFTER WHOLE-BODY ROENTGEN IRRADIATION AS WELL AS AFTER LOCAL IRRADIATION OF THE HEART REGION. Jan Jonek and Stanislaw Kosmider. Strahlentherapie, 122: 198-210(Oct. 1963). (In German)

The activity and distribution of several enzymes in heart muscle during different states of radiation sickness as well as after local irradiation of the heart were investigated histochemically. Guinea pigs received whole-body irradiation and local irradiations with 400 r each. Twenty-four hours after whole-body irradiation an increase and later on a decrease of DPNH-diaphorase and succinic acid dehydrogenase was observed. ATP-ase and alkaline phosphatase increased their activities during the first few days after irradiation; later on a decrease in activity was found. The activity of the acid phosphatase increased proportionally with the development of the radiation sickness. This effect might be due to degeneration events within the sarcoplasm. A decrease was observed for the non-specific esterases, while the activity of the E-600-resistant esterases increased. The results point out disturbances in heart muscle metabolism caused by radiation. This is proven by the decrease of enzymes which take part in the oxygen phosphorylizing events and in the active substrate transport from serum into the sarcoplasm. The histochemical picture 4 days after local irradiation of the heart is similar to the one obtained 24 hr after whole-body irradiation. This is explained as due to a direct effect of x rays on the heart muscle. (auth)

3555 THE EFFECTS OF ROENTGEN WHOLE-BODY IRRADIATION ON THE ENZYMATIC ACTIVITY OF LEUCINE-AMINO-PEPTIDASE GLUTAMATE-OXALATE- AND GLUTAMATE-PYRUVATE-TRANSAMINASE IN DIFFERENT ORGANS OF MICE. Heribert Braun, Guenther Hornung, and Eberhard R. Heise (Universität, Wurzburg, Ger.). Strahlentherapie, 122: 211-21(Oct. 1963). (In German)

White mice received whole-body irradiation of 450 r. The activities of the leucine-amino-peptidase, glutamic-oxalacetic-transaminase, and glutamic-pyruvate-transaminase were investigated 2 to 14 days after irradiation. Twelve of 47 examined animals died at different intervals after irradiation. The irradiation caused a slight decrease of the wet weight of heart, liver, and kidney and a slight decrease of the protein content of the organ homogenates. The activity of the leucine-amino-peptidase showed a significant decrease in all organs by the 2nd day after irradiation; the activity of the glutamic-oxalacetic-transaminase increased at the same day in all organs; and the activity of the glutamic-pyruvate-transaminase showed at the same time a distinct increase only in the liver homogenates. A delayed increase of the pyruvate-transaminase was found in kidney homogenates. On the 14th day after irradiation an increase of leucine-amino-peptidase and glutamic-oxalacetic-transaminase was found in all organs. (auth)

3556 CONCERNING DIFFERENCES IN THE REPAIR OF RADIATION-INJURED RAT SPLEENS. A HISTOLOGICAL AND CYTOLOGICAL STUDY AT 2 AND 8 DAYS AFTER 600-r WHOLE-BODY IRRADIATION AND 10-DAY PRE-IRRADIATION WITH 3 r DAILY. Lothar Diethelm and Werner Lorenz (Universität, Mainz). Strahlentherapie, 122: 222-47(Oct. 1963). (In German)

Three hundred ten male albino rats (130 to 180 g) received 1 × 600 r or 10 × 3 r + 1 × 600 r whole-body irradiation. Life expectancy was the same in both groups. Histological investigation of the spleen on the 2nd and the 8th day after 1 × 600 r or 10 × 3 r + 1 × 600 r showed no signs that the pre-irradiation with x rays for 10 days influenced significantly the radiation sensitivity or recovery ability of the spleen irradiated with 1 × 600 r. There were great differences in the spleen reaction in all groups. About 10% of the pre-irradiated or not pre-irradiated animals showed no histological spleen damage 2 days after 600 r. Cytological investigations of smear preparations were found very valuable in addition to the investigation of slices of the spleen. There was a very active and multiform hematopoiesis in about $^3/_5$ of the rats by the 8th day after 1 × 600 r or 10 × 3 r + 1 × 600 r. The lymphopoiesis, originating from the large lymphatic reticulum cells was surpassed by the hematopoiesis of the red splenic pulp, and, in the beginning, by an active erythropoiesis and megakaryopoiesis, as well as by plasmoblasts, lymphoid plasma cells, and new formation of granulocytes. Very significant was the regeneration activity and pluripotency of the young reticulum cells of the spleen. (auth)

3557 REPORT ON THE HISTOLOGY AND CYTOLOGY OF IRRADIATED THYMUS. PART II. Hildegard Braun (Universität, Freiburg i. B.). Strahlentherapie, 122: 248-57 (Oct. 1963). (In German)

Thymus cells from whole-body-irradiated mice (800 r) were observed by electron microscope and the radiation effects upon the substructure of the lymphocytes and of the reticular cells were compared with each other. Immediately after the radiation insult, the space between both nuclear membranes starts to form vacuoles which finally fill out the whole space near the nucleus. The organelles of the cytoplasm, the mitochondrias and especially the endoplasmatic reticulum are almost unchanged to the time of the nuclear pycnosis. The radiation effect is only transient on the nuclear membrane of the reticular cells but is pronounced on the structures of the cytoplasm. The mitochondria as well as the well-developed endoplasmatic reticulum can control the damage of the cell nucleus. (auth)

3558 COMPARATIVE FINE-TISSUE INVESTIGATIONS OF THE RADIATION SENSITIVITY OF INOCULATION TUMORS OF RATS. Joachim Arndt, Kurt Hambsch, and Reinhard Ludewig (Karl-Marx-Universität, Leipzig). Strahlentherapie, 122: 263-9(Oct. 1963). (In German)

The cytostatic effectiveness of x rays and radiomimetics cannot be characterized sufficiently by reporting the decrease of tumor and body weight. Therefore, systematic histologic investigations of irradiated inoculation tumors of rats were done. It was found that the histologic changes caused by x irradiation are dose dependent and tumor specific, and that they make possible a comparison of x ray sensitivity. (auth)

3559 ALTERATION OF ACQUIRED RADIATION RESISTANCE. Sridhara Bhaskaran and Wolfgang Dittrich (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 122: 270-8(Oct. 1963). (In German)

Radiation-resistant lines of Ehrlich ascites tumor were developed by serial x irradiation of the stem line under aerobic conditions. This resistance remained even after 100 animal passages. The acquired radioresistance of the tumor following a single irradiation is expressed, among

other ways, by an increase in malignancy of the tumor in the host animal. The chromosomes of the serially irradiated lines show some morphological changes as compared to the stem line. The modal chromosome number is increased by 2. (auth)

3560 THE TISSUE CHANGES PRODUCED WITH THE HELP OF THE COVER-GLASS METHOD WITH HIGH MUSTARD GAS-PHOSPHAMIDE ESTER, TRIETHYLENE-IMINOBENZOQUINONE, AND X-RAY DOSES. Rudolf Schneider (Universität, Marburg/Lahn, Ger.). Strahlentherapie, 122: 290-9(Oct. 1963). (In German)

The dynamics of microscopic tissue changes caused by increasing dosages of cytostatics and radiation was investigated. Factors that favor a lymphoid genesis of the mononuclear cells are discussed. (auth)

3561 THERMAL CONDUCTIVITY MEASUREMENTS ON THE HUMAN SKIN UNDER THE INFLUENCE OF ULTRAVIOLET AND X RADIATION. Hans-J. Heite and Marlies Wurbs (Universität, Freiburg i. B.). Strahlentherapie, 122: 300-10(Oct. 1963). (In German)

The thermal conductivity number λ_0 and the control value λ_1, respectively, of the skin were determined on 30 forearms (inner side) of 24 normal volunteers or patients (who were being treated with x rays for cancer) under the conditions of throttling and normal circulation, respectively. The measurements were done before and at different times after x irradiation (1000 r short source skin distance conditions) and ultraviolet radiation (5 fold erythema threshold). Previous investigations showed that repeated measurement of λ_0 on the same skin area (removing and replacing of the detector) can be done with sufficient reproducibility. A significant increase of the thermal conductivity number λ_0 of the skin (throttling value) was observed 24 and 72 hr after x irradiation. Uv-irradiation did not show a significant change in thermal conductivity using the same experimental conditions. An explanation by means of which these results might be explained is discussed. (auth)

3562 THE BIOLOGICAL EFFECT OF IONIZING RADIATION ON VARIABILITY IN SPRING WHEAT DURING ITS CONVERSION TO THE WINTER HABIT. V. K. Karapetyan. Tr. Inst. Genet., Akad. Nauk SSSR, No. 29, 194-206(1962).

Investigations were made to show that when spring wheat is irradiated, forms differing in their developmental habit arise. Air-dry seeds of the Armenian spring variety Erinaceum (Triticum compactum var, erinaceum) were treated with Co^{60} gamma rays at dosages ranging from 8 to 16 kr. The 10-16 kr doses were excessive, but a number of plants derived from 8 kr-treated seed survived the winter when sown in autumn and were in fact shown to be winter forms genetically. After two generations of autumn sowing, different families of the progeny of one of the surviving plants showed survival percentages of 37.8 to 82.4%. They were incapable of earing when sown in spring. Subsequently other winter forms were obtained in a similar manner, having greater overwintering capacity than the standard winter wheat variety Ukrainka. The winter selections produced grain yields that were, on the average, 10–12% higher than in the original spring form. They were often early maturing, and had a long vernalization stage, not less than 50-55 days. 60% of the winter forms resembled the original variety morphologically. Some of the winter forms were compact, with strong, lodging-resistant straw; grains were often large, vitreous, uniform, and high in protein. The compact forms were genetically stable, retaining their properties in successive generations. It is thought that some of the types that combine earliness, winter hardiness, and high productivity will be of practical value. In assessing the results it is pointed out that the treatments applied offer a very rapid way of converting spring into winter wheat. The effects are caused by environmental influence on plants with shattered inheritance. (TCO)

3563 EFFECT OF GAMMA RADIATION ON PLANT METABOLISM. N. B. Vezirova. Tr. Nauchn.-Issled. Inst. Zemledeliya, Min. Proizv. i Zagotovok Sel'skokhoz. Produktov Azerb. SSR, 8: 85-93(1961).

Swollen tomato seeds were irradiated with γ-radiation in doses of 500 to 8000 r, and then planted. The plants were grown on a background of NH_3- and nitrate-N. Enzyme activity was measured in leaves of the middle level. Polyphenol oxidase activity increased in young plants and decreased in old plants grown from irradiated seeds. Peroxidase activity decreased on a nitrate-N background and increased on NH_3 background, independently of the radiation dose. Irradiation increased catalase activity on a nitrate-N background and caused no changes on the NH_3 background. The I-reducing capacity of leaves was increased by γ-irradiation. Tomato yield increased only in the case where the seeds received low γ doses. (Ref. Zh., Biol. Khim.)

3564 ATTRITION IN THE HIROSHIMA ADULT HEALTH STUDY: FIRST CYCLE ANALYSIS. Paul S. Anderson, Jr. (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Yale J. Biol. Med., 36: 75-90(Aug. 1963).

Participation data for the first cycle of the Adult Health Study conducted in Hiroshima during the period July 1958 to December 31, 1960 were presented. The continuing medical examination program includes approximately 13,700 individuals and was designed to investigate the late effects of nuclear irradiation on man. The study population is composed of four exposure groups of equal size, matched by age and sex. Participation scores were analyzed by exposure, age, sex, and socioeconomic variables, as well as by a history of previous contact with the ABCC programs. Significant differences were demonstrated between the participation scores by age, marital status, history of prior contact with ABCC, and occupation (this latter category was significant only for males). Although differences were observed for these variables, the significance was usually attributable to one discrepant category in each of the variables, often the least populated. A trend was apparent with respect to exposure, with the lowest participation noted in the nonexposed and the highest participation in the exposed with symptoms group; however, the absolute differences were not statistically significant when analyzed in relation to all of the remaining variables. Sex differences were not significant. Although relatively minor differences were demonstrated for some variables, the outstanding features are the remarkably low attrition rates observed. Only nine per cent of the population was in the so-called refusal category and over 80 per cent of the living population, including non-Hiroshima residents, were examined during the first cycle of the program. (auth)

3565 POSLEDSTVIYA VOZDEISTVIYA IONIZIRUYUSHCHEI RADIATSII VO VREMYA BEREMENNOSTI. (Sequels of Ionizing Radiation Effects During Pregnancy). N. A. Kalinina. Leningrad, Publishing House of Medical Literature, 1963. 96p.

Effects of ionizing radiation during pregnancy, delivery, and the lactation period are analyzed as well as the effects of radiation trauma on the fetus. Some data are given on prophylaxis against injury to the progeny and the role played by the mother in injuries in the fetus. (R.V.J.)

3566 OSTRYE RADIOATSIONNYE PORAZHENIYA I IKH LECHENIE. (Acute Radiation Injuries and Their Treatment). I. M. Poltavets, F. F. Sinitsyna, M. P. Filippov, and M. P. Kolyada. Kiev, Medizdat, 1962. 156p.

Therapy of acute and chronic radiation injuries is described. An analysis was made of pathological changes in organisms suffering from radiation sickness. Sorting and evacuation measures in nuclear attack, and organization of dosimetric control of medical personnel are described using up-to-date data. (R.V.J.)

3567 THE EFFECT OF GAMETIC GENOTYPE ON THE RADIATION SENSITIVITY OF DROSOPHILA SPERM. D. L. Lindsley, C. W. Edington, and E. S. von Halle (Oak Ridge National Lab., Tenn.). p.63-76 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

Irradiation of Drosophila males may produce a shift in the ratios of the different genotypes recovered among the progeny. A method was developed for treating progeny ratios following paternal irradiation as the ratio of two survival functions, where survival refers to the ability of a mature sperm of a particular genotype to produce an adult fly in the next generation. Although chromosome loss and among-experiment variability contribute imprecision to the model as it stands, the following tentative conclusions were drawn: X-bearing sperm and Y-bearing sperm exhibit virtually identical sensitivities to radiation, and sperm with two sex chromosomes are more sensitive than sperm with one sex chromosome which are in turn more sensitive than sperm lacking a sex chromosome. The portion of the proximal heterochromatin lying between the right breakpoints of $In(l)sc^4$ and $In(l)sc^8$ or $In(l)sc^{51}$ has no effect on the sensitivity of X-bearing sperm when it is in its normal proximal position, but when it is shifted to the distal terminus of the X chromosome, as it is by $In(l)sc^8$ or $In(l)sc^{51}$, it causes an increase in the sensitivity of the X-bearing sperm. Closing the X chromosome, i.e. using a ring-shaped X, causes a large increase in the sensitivity of X-bearing sperm. (auth)

3568 STAGE SENSITIVITY TO X-RADIATION DURING MEIOSIS AND MITOSIS IN THE EGG OF THE WASP HABROBRACON. R. C. von Borstel and W. St. Amand (Oak Ridge National Lab., Tenn. and Univ. of Mississippi, University). p.87-100 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

Oocytes in the first meiotic metaphase are considerably more sensitive to x radiation than oocytes in the first meiotic prophase. A brief sketch of work is presented that encompasses all of oogenesis as well as the first two mitoses of the young Habrobracon embryo. In Habrobracon unfertilized eggs develop into haploid males, fertilized eggs into diploid females. Total lethality (recessives and dominants) in the unfertilized egg is the criterion of damage unless otherwise specified. In Habrobracon 85 per cent or more of these are true dominant lethals. (auth)

3569 THE EFFECT OF RADIATION DOSE RATE AND FRACTIONATION ON MUTATION IN MICE. W. L. Russell (Oak Ridge National Lab., Tenn.). p.205-35 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

Results are reviewed of several of recently completed or current experiments that have a bearing on repair from genetic radiation damage and differential radiosensitivity in germ cells. The presentation is restricted to data obtained with the specific locus method (Russell, 1951). The experiments reported fall into two groups: those measuring the effect of varying the dose rate of continuous irradiation and those investigating the effect of dose fractionation. (auth)

3570 ARE CHRONIC AND ACUTE GAMMA IRRADIATION EQUALLY MUTAGENIC IN DROSOPHILA? H. J. Muller, I. I. Oster, and S. Zimmering (Indiana Univ., Bloomington; Inst. for Cancer Research, Philadelphia; and Brown Univ., Providence). p.275-311 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

Drosophila oogonia were irradiated with Co^{60} γ and the progeny studied for the appearance of sex-linked lethals. When doses and dose-rates were gaged by means of physical dosimetry alone it was found that a given dose induced about 1.6 times as many sex-linked recessive lethals in the immature oogonia of adult Drosophila melanogaster, when they were irradiated at their lowest or dead level stage of sensitivity, if the radiation were delivered in the form of a single acute dose in about half a minute, at 44×10^4 r/hr, as it did if it were delivered in the form of a chronic dose extending over two weeks, at 12 r/hr. Again using only physical dosimetry, doses of 4000 r delivered at lower rates, extending down to 1.5 r/hr, gave no evidence of a further drop in the mutagenic effectiveness of the radiation. Still using only physical dosimetry, the results of 4000 r delivered at dose-rates measured as being in the range of 120 to 60 r/hr showed good agreement with the results of the acute irradiation, and highly significant disagreement with those of the irradiation at 12 r/hr and lower, when the irradiations in the 120 to 60 r/hr range were carried out in the so-called hot room of the Brookhaven National Laboratories. On the contrary, when the irradiations in the 120 to 60 r/hr range were carried out in the so-called dilution room, the observed frequencies of induced lethals showed good agreement with those obtained for 12 r/hr and lower, and highly significant disagreement with those of the acute irradiation. A series of irradiations of spermatozoa in inseminated females was carried out in order to determine to what extent the frequencies of recessive sex-linked lethals induced in these well-studied stages corresponded with the expectations based on the physical dosimetry. It was found that the frequencies obtained from acute irradiation in the hot room, and also from chronic irradiation, at 12 r or less per hour, in the dilution room, were some 90 per cent (±5 per cent) as high as expected for the supposed doses. In contrast to these results, the frequencies obtained from chronic irradiation at intended rates of either 60 or 12 r/hr in the hot room were about 120 per cent (±5 per cent) of those expected for the supposed doses. Application of correction factors for the doses used would remove all decisive differences in the per-r lethal frequencies. However, 12 r/hr given in the hot room was reckoned by this method to have only half the mutagenic effectiveness shown by all these other treatments. A series of irradiations was thereupon carried out in which both spermatozoa in the female and oogonia were irradiated simultaneously. Most of the values directly observed for oogonia agreed satisfactorily with those obtained previously. However, after application of correction factors based on the results from the spermatozoa simultaneously given the same treatment, other values for oogonia were obtained. The 12 r/hr irradiation in the hot room, giving a calculated lethal frequency of only 0.9 per cent, appeared to be only about 0.4 as effective as the acute irradiation, and 0.7 as effective as chronic irradiation given in the dilution room. In an attempt to throw light on the discrepancy, as well as on lesser yet significant discrepancies in other cases, extensive tests were carried out of the possible influence of the following fac-

tors: delay in germ-cell maturation caused by irradiation or otherwise; natural differences in reproductive activity; differences in nutrition; presence or absence of a presumptive radioprotective agent (AET); exposure in center or near periphery of radiation field. None of the results indicated that any of these factors had affected the mutation frequency. (auth)

3571 THE RELATIVE SENSITIVITY OF VARIOUS GERM-CELL STAGES OF THE MOUSE TO RADIATION-INDUCED NONDISJUNCTION, CHROMOSOME LOSSES AND DEFICIENCIES. Liane Brauch Russell and C. L. Saylors (Oak Ridge National Lab., Tenn.). p.313-42 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

An attempt was made to derive an over-all picture of relative radiation sensitivities of the various germ-cell stages of the mouse, both to the induction of chromosome aberrations and to cell killing presumed to be independent of aneuploidy. It is shown that there is neither a direct nor an inverse relation between the two types of effect. New data presented pertain to aberrations not heretofore used in cell-stage comparisons, namely, deficiencies, monosomy, and trisomy of the sex chromosomes. On combining these data with results on other aberrations, reported earlier, the following over-all picture of relative chromosomal sensitivities is obtained. The most extreme sensitivity occurs in meiotic metaphase-I of oogenesis, and in both paternally and maternally contributed chromosomes of the early pronuclear stage of the zygote. The smallest yield of chromosome aberrations is obtained from spermatogonia. Other gametogenic stages are intermediate. During spermatogenesis, spermatids, yield the highest rate of chromosome breakage; and spermatocytes, as a group, are approximately equal to spermatozoa in aberration yield, although spermatocytes irradiated in the middle period of development may approach spermatids in induced XO frequency. However, the comparison of spermatocytes with postmeiotic stages is complicated by various factors. Spermatozoa irradiated in the vas are more sensitive than testicular sperm. Prophase oocytes may resemble spermatocytes, but the information is, as yet, not very extensive. In general, comparisons with results obtained in other species yield close parallelism. It is clear that no one factor will emerge as responsible for all the sensitivity differences. Various conditions found in mouse gametogenesis and fertilization—such as the synchrony in egg maturation, the long interval between sperm penetration and the first cleavage, and the clear separation that can be made between spermatogonia and postgonial stages—provide excellent opportunities for elucidating the mechanisms involved in differential sensitivity. (auth)

3572 IMMUNOLOGIYA OSTROGO LUCHEVOGO PORAZHENIYA. (Immunology of Acute Radiation Sickness). A. I. Zavodchikova, ed. Moscow, Gosatomizdat, 1962. 266p.

The effect of radiation on antimicrobic immunity, infectious complications in irradiated animals, and noninfectious immunology are discussed. The book is intended for radiobiologists, physicians, and investigators in the field of radiation sickness. (H.M.G.)

3573 STERILIZATION BY GAMMA RADIATION FOR THE CONTROL OF THE NAVEL ORANGEWORM PARAMYELOIS TRANSITELLA (WALKER) (LEPIDOPTERA: PHYCITIDAE). Mohamed Mamdouh Husseiny. Thesis, Berkeley, Calif., Univ. of California, 1963. 92p.

The possibility of using the sterile insect technique for the control of the navel orangeworm Paramyelois transitella (Walker) was investigated. Studies were made to determine if gamma rays could be used to sterilize the navel orangeworm without causing serious adverse effects on mating behavior. A cobalt-60 unit was set to give approximately 197500 rads per hour. Mature pupae, 8 days old, were found to be the most desirable stage to irradiate without causing appreciable damage to the insect. This stage was also the most convenient to handle and could be easily sexed. At a dosage of 160000 rads no adults were able to emerge. At 80,000 rads, over 50% of both males and females were still able to mate but reduction in egg laying was considerable in the case of irradiated females. Complete sterility was obtained in both sexes when mature pupae were exposed to 50000 rads. At this dose, longevity, egg laying, and mating habits did not seem to be affected. No effect on fertility was detected when the insects were exposed to 20000 rads or less but drastic reduction in fertility was obtained at 30000 and 40000 rads of gamma radiation. When exposing other stages of the navel orangeworm to gamma radiation, eggs were more susceptible to radiation damage than mature larvae and the latter stage more so than mature pupae. After obtaining complete sterility, laboratory tests were carried out to determine the efficiency of sterile males and females in reducing the number of fertile eggs deposited by normal moths. This was done by introducing sterile and fertile insects into oviposition cages in varying ratios. The results showed that sterile females could be used as successfully as sterile males and that much better results might be obtained by using both sterile males and females for the control or eradication of the navel orangeworm. Mating behavior in the laboratory and field was also investigated. By dissecting the females and counting the spermatophores in the bursa copulatrix, it was possible to determine the number of times each female has mated. From these investigations it was clear that most females mate but once in the field and only 8% mated twice. Both males and females seemed to mate with about the same frequency when the sex ratio is about 1:1 which is the ratio found in this insect. (TCO)

3574 LONG-TERM EFFECTS OF X-IRRADIATION AND AGING IN THE SKIN OF MICE. Paul Donald Forbes. Thesis, Providence, Brown Univ., 1961. 54p.

The skin of mice aged two weeks to 30 months was utilized in an aging study. Aging symptoms were compared with characteristics of irradiated skin; comparisons were made during the period between one day and 18 months after small skin areas received 500, 1000, or 3000 r of x rays as a single dose, or after a 500 r systemic exposure. Certain age-dependent alterations in skin structure and function involved hair growth. The number of hair-producing follicles per square millimeter decreased with increasing age. This is primarily due to a loss of normal follicle organization, although changes in body weight do influence density. A lengthening of the time period between plucking and the cessation of all hair growth in an area became evident with increasing age of the animal. Histological preparations demonstrated an asynchronism in the population of follicles, the actual growth time of individual follicles probably remaining constant. The area of skin responding with hair growth, relative to the area plucked, decreased with age, perhaps reflecting a change in the growth threshold properties of the skin. The frequency of the appearance of bald spots increased with age. This condition is considered an abnormal consequence of aging, however, because hair loss is mediated by a histopathological disruption of follicles during the hair growth period. (TCO)

3575 THE EFFECTS OF X-RAYS ON THE PROGRESS OF MAMMALIAN CELLS THROUGH THE DIVISION CYCLE IN VITRO. Stanley Mak. Thesis, Toronto, Univ. of Toronto, 1962. 146p.

The effects of x rays on the progress of strain-L mouse cells from G_1 to S, through (rate of DNA synthesis), and from S to G_2 were studied using isotopically labeled specific DNA precursors and autoradiography. The dose of x rays used ranged from 600 to 11000 rads. It was found that the progress of cells through all portions of the cycle was affected by x rays. The fate of the cells irradiated in different portions of the division cycle is discussed. (TCO)

3576 MOLECULAR RADIOBIOLOGY OF HUMAN CELL LINES. Raymond Leo Erikson. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 101p.

Human tissue culture cells were sensitized to x-ray and ultraviolet light irradiation by culturing them in medium containing equimolar (2×10^{-6} M) concentrations of 5-bromodeoxyuridine (BUdR), 5-chlorodeoxyuridine (CUdR), or 5-iododeoxyuridine (IUdR) plus 5-fluorodeoxyuridine to inhibit thymidylate synthesis. The increase in D_{37} (dose required to kill 63% of the surviving cells on the straight-line portion of the survival curve) was utilized to measure radiosensitivity. The sensitization factors (D_{37} control cells/D_{37} treated cells) for the cells were 1.6 (CUdR), 1.8 (BUdR), and 2.4 (IUdR) for x rays. The corresponding uv sensitization factors were 1.6, 10.0, and 2.0. IUdR was shown to be incorporated into DNA of cells grown in its presence by banding the isolated DNA in a Cs_2SO_4 density gradient. The increased density of this DNA can be related to the amount of IUdR incorporated. The labeling was compatible with a semi-conservative mode of DNA replication. The relationship between the radiosensitivity of cells and the extent of IUdR incorporation was determined for cells grown in medium containing different concentrations of IUdR. The x-ray sensitization factors were 1.0 (10^{-6} M IUdR), 1.2 (10^{-7} M), 1.6 (10^{-6} M), 2.6 (10^{-5} M) and 3.2 (5×10^{-5} M). IUdR incorporation and the sensitization factor increased with increasing concentration of IUdR in the medium. However, cell viability decreased sharply from 60% at 10^{-5} M to 6.0% at 5×10^{-5} M IUdR. Two cell cultures were grown under conditions such that one contained IUdR incorporated into both strands of DNA while the other contained the same quantity of IUdR incorporated in only a single DNA strand. Both cultures displayed the same radiosensitivity, indicating that the location of IUdR in the DNA molecule is unimportant, but that the total quantity incorporated determines the radiosensitivity of the cell. Glycerol present in the medium in which the cells are suspended for x irradiation caused a marked decrease in cell death. Glycerol protected BUdR- or IUdR-labeled cells to the same degree as control cells without eliminating the radiosensitization of an analogue. This indicates that the radiosensitization is an intrinsic cell property and is independent of the level of radiation protection. Experiments were performed to compare radiosensitization of tissue culture cells and incorporation into DNA of 5-halogen derivatives of deoxyuridine (BUdR and IUdR) and deoxycytidine (BCdR and ICdR). Under identical conditions the deoxyuridine and deoxycytidine analogues were incorporated to the same extent into DNA, producing about the same degree of radiosensitization. It was found that radiation resistance increased after the resumption of DNA synthesis in the period immediately after removal of the inhibitor, reaching a maximum just prior to division. After division the resistance of the cultures decreased, approaching that of an unsynchronized culture. (TCO)

3577 STUDIES ON THE RADIATION RESISTANCE OF SPORULATING CELLS OF BACILLUS SUBTILIS. Durwood Benedict Rowley. Thesis, Syracuse, N. Y., Syracuse Univ., 1963. 196p.

Studies were made on the development of x-ray resistance in endotrophically sporulating cultures of Bacillus subtilis (ATCC 6633) with special reference to changes in the radioresistance of glutamic-pyruvic transaminase (GPT), glutamic-oxaloacetic transaminase (GOT), malic dehydrogenase, and succinic dehydrogenase. Cells of B. subtilis grown in a synthetic medium for 17 hr, subsequently washed with phosphate and transferred to phosphate (20 mg $CaCl_2$/liter) sporulated in a reproducible pattern; approximately 65 to 70% of the cells formed heat resistant spores (80 C for 15 min) between 4 and 8 hr of incubation. Radioresistant cells appeared 2 to 3 hr before thermoresistant cells and the formation of dipicolinic acid. These data suggest that the mechanisms responsible for resistance to heat and x rays are probably independent of each other; also, the onset of radiation resistance in sporulating cells is probably independent of the presence of dipicolinic acid. The D_0 (37% survival dose) values for vegetative cells and endotrophically formed spores were 6 to 8 krep and 68 to 72 krep, respectively. The effect of x rays (260 krep) on transaminase activity was determined in cells and cellular extracts during various stages of endotrophic sporulation. Very large radiation doses were necessary to inactivate the transaminases in intact cells. As sporulation proceeded from 0 hr to 12 hr the transaminases showed a decreased radioresistance as indicated by a reduction in D_0 values from 8.8 to 2.9 megarep for GOT, and from 1.7 megarep to 0.9 megarep for GPT. When 0-hr extracts were irradiated, D_0 values of 420 ± 36 krep and 290 ± 9 krep were demonstrated for GOT and GPT, respectively. However, in irradiated extracts the transaminases showed essentially no change in radioresistance during sporulation. In 0-hr intact cells the dehydrogenases were completely resistant to at least 260 krep, indicating that the probable D_0 values for malic and succinic dehydrogenase exceeded 9 megarep. However, in 0-hr extracts malic dehydrogenase and succinic dehydrogenase exhibited D_0 values of 1700 ± 700 krep and 2500 ± 1000 krep, respectively. Also, their radioresistance decreased markedly during the first 4 hr of sporulation. Various reasons for the observed decreases in enzyme radioresistance during sporulation were discussed. Insofar as the dehydrogenases and transaminases investigated, there was no apparent correlation between the development of spore radioresistance and enzyme radioresistance. However, the results suggest a possible correlation between an increase in endogenous respiration and x-ray resistance of sporulating cells. It is suggested that physiological changes may be responsible for the initial increase in radioresistance of endotrophically sporulating cells. (TCO)

3578 THE INACTIVATION OF ANTIBODY BY COBALT-60 GAMMA RADIATION. Anne-Louise Jackson. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 140p.

The inactivation of antibody activity was investigated by cobalt-60 irradiation of immune rabbit γ_2 globulin preparations. Three different antibody systems directed against human serum albumin (anti-HSA), azo-bovine gamma globulin (anti-azo-BGG), and p-azobenzoate (anti-PAB) were each exposed to increasing radiation doses at a protein concentration of 10 mg/ml in 0.15 M sodium chloride. After irradiation, analysis of antibody activity by the quantitative precipitation technique resulted in nonspecific precipitation of protein, which masked antibody inactivation.

Post-irradiation dialysis against water resulted in partial precipitation of protein. When the precipitated protein was removed by centrifugation, analysis of the supernatant fluid showed an exponential relationship between radiation dose and antibody activity. Both combining and precipitating activity of anti-PAB were lost at the same rate. This was established when the inactivation dose was found to be the same whether activity was measured by hapten binding or the quantitative precipitation technique. Antibody inactivation was caused by free radicals formed by ionizing radiation in aerated water. This indirect mechanism was demonstrated by the dependence of percentage inactivation on protein concentration and by the absence of inactivation when antibody was irradiated in the frozen state. The free radical OH^0 was implicated as the major inactivating agent since the extent of antibody inactivation remained the same when the concentration of the HO_2^0 radical was presumably decreased by irradiation at lowered oxygen tension. Hydrogen peroxide at a concentration of 10^{-3} M also failed to affect antibody activity. Specifically purified preparations of precipitating antibody exposed to ionizing radiation at equal antibody and total protein concentration showed no significant change from antibody inactivation values determined for nonpurified preparations, demonstrating that RGG and antibody react to the same extent with ionizing radiation. The inactivation doses obtained for the irradiated, water-dialyzed antibody systems were 230×10^3, 290×10^3 and 455×10^3 rep for anti-HSA, anti-azo-BGG, and anti-PAB respectively. These doses represent the formation in water of 11, 13, and 23 ion pairs per molecule, respectively. The differences are significant in that they are greater than the experimental error (±10 per cent). (TCO)

3579 VARIATION IN QUANTITATIVE CHARACTERS OF OATS (AVENA SATIVA) AFTER DIFFERENT MUTAGEN TREATMENTS. Raul Abrams. Thesis, Ames, Iowa, Iowa State Univ., 1963. 71p.

Several mutagens, namely, thermal neutrons, P^{32}, and ethyl-methanesulfonate, were compared for their relative efficiencies to induce genetic variability for the quantitatively inherited characters, heading date, plant height, and weight per 100 seeds, in Clintland 60 variety of hexaploid oats (Avena sativa). One lot of seeds was treated each of the following: 2.03×10^{13} neutrons per square centimeter; 0.12 M ethyl-methanesulfonate solution for 4 hours; a solution with 2 μc of P^{32} per seed for 72 hours; 0.12 M ethyl-methanesulfonate for 2 hours and a solution with 1 μc of P^{32} per seed for 72 hours, and no treatment. In addition 200 oat culms were injected with 0.10 M ethyl-methanesulfonate at the boot stage. The occurrence of fatuoid and chlorophyll-deficient mutants in the M_2 generation of mutagen-derived populations only attested to the efficiency of the mutagens to induce mutations. In the M_3 generation, the genetic variability among families and among lines within families (except for plant height in the P^{32} population) was significantly increased by all mutagens, as determined by the analyses of variance, ratio of mutagen-treated to check mean squares, and variance components. Thermal neutrons and ethyl-methanesulfonate produced the greatest variability for all three quantitative characters. The estimates of genetic coefficients of variability and heritability percentages increased from the M_2 to the M_3 generation. This suggested that selection for seed weight, plant height, and heading date should not be practiced until at least the M_3 generation. The genetic correlations among characters heading date, plant height, and weight per 100 seeds generally were low for ethyl-methanesulfonate, intermediate for thermal neutrons, and high for P^{32}. Additional indirect evidence on types of mutations produced was obtained by comparing the seed weight frequency distributions for the neutron- and ethyl-methanesulfonate derived populations. The magnitude of variation of the individual oat lines, as determined by the kurtosis values and from frequency distributions, were small for ethyl-methanesulfonate and large for the thermal neutron treatment. (TCO)

3580 INSECT POPULATION CONTROL BY THE STERILE-MALE TECHNIQUE. Comprehensive Report of a Panel Held in Vienna, October 16-19, 1962. A. W. Lindquist, ed. (International Atomic Energy Agency, Vienna). Technical Report Series No. 21. (STI/DOC/10/21)

The successful eradication of the screw worm fly from the Southeastern part of the United States by the release of radiosterilized males is reviewed. The possibility of using this method for the control of other insect pests is discussed, with emphasis on the Mediterranean and other fruit flies, the olive fly, the tsetse fly, the Australian sheep blowfly, the New Guinea screw worm, the tropical ox warble, the codling moth, boring insects, flour moths, and other grain pests. Problems and procedures are described in detail. (C.H.)

3581 AUTORADIOGRAPHIC DEMONSTRATION OF THORIUM DEPOSITION IN TISSUES. A CASE REPORT. Henry Ianz and Sue Keller (Veterans Administration Hospital, Dallas and Univ. of Texas, Dallas). 12p. (CONF-164-8)

From Society of Nuclear Medicine 10th Annual Meeting, Montreal, June 1963.

A case is reported of a patient suffering from a fatal myocardial infection. Case history and autopsy studies revealed that cerebral arteriograms using Thorotrast some nine years previously had resulted in a nine-year splenic dose of approximately 1500 rad. No malignant processes were found at autopsy, likely because of the relatively short time interval involved since Thorotrast administration. Spleen and liver autoradiograms superimposed on photomicrographs are included. (H.M.G.)

3582 PROGRESSIVE ALTERATION OF SERUM PROTEINS IN RATS SEVERAL MONTHS AFTER AN ACUTE OR PROTRACTED IRRADIATION. R. Ghys and A. Reuter (Laval Univ., Quebec). 8p. (CONF-294-1)

From Canadian Federation of Biological Societies 6th Annual Meeting, London, Ont., Canada, June 1963.

Delayed changes of the serum proteins in male Sprague Dawley rats that survived the acute radiation syndrome were investigated. Doses of Co^{60} γ ranging from LD_0 to LD_{50} were given to rats six to eight weeks of age. Paper electrophoreses and microdosage of proteins by the buiret method were performed on plasma proteins for 206 rats: 29 with acute irradiation; 73 chronic irradiation; 44 acute irradiation following cold acclimatization; and 60 normal animals. No significant variations in the total serum proteins were found in any one group. Alpha globulins were found to be slightly above normal in some irradiated rats, but there was no significant variation in the β globulin fraction. Gamma globulins showed a marked and consistent increase following irradiation. Thus for observed protein changes in irradiated rats have not proven to be dose dependent. It is suggested that the changes may provide a link between early irradiation syndrome and late effects. (H.M.G.)

3583 TREATMENT OF VIRUSES. John R. Polley (to Minister of National Health and Welfare). Canadian Patent 660,388. Apr. 2, 1963. Filed June 13, 1961.

A vaccine preparation method was developed for de-

stroying the infectivity of live viruses while retaining the antigenicity. The method comprises exposing the virus to 0.5 to 6 × 10^6 rad of ionizing radiation (preferably gamma) in the presence of a protective agent. The protective agent is antioxidant in nature and should be used in amounts from 0.05 to 0.3% (wt/vol). Histidine and sodium p-aminohippurate are preferred for influenza and mumps viruses respectively. The protective effects of various chemicals on the antigenicity of irradiated influenza A virus are illustrated. (D.L.C.)

Radiation Effects Therapy and Countermeasures

3584 (JPRS-22000) THE EFFECT OF SEX HORMONES ON THE COURSE OF ACUTE RADIATION SICKNESS. S. A. Davydova. Translated from Patol. Fiziol. i Eksperim. Terapiya, 7: No. 5, 45-8(Sept.-Oct. 1963). 6p. (OTS-63-41215)

The protective and therapeutic effects of sex hormones, both estrogens and androgens, against radiation injuries were studied in 1181 mice and 555 rats exposed to doses of 650 to 700 r of Co^{60} γ radiation. Administration of sex hormones proved unsuccessful or aggravated the development of symptoms of acute radiation sickness. (C.H.)

3585 INDUCTION OF CATARACTS IN MICE BY 4-(p-DIMETHYLAMINOSTYRYL) QUINOLINE. Kenneth W. Christenberry, James W. Conklin, Arthur C. Upton, and G. E. Cosgrove (Oak Ridge National Lab., Tenn.). Arch. Ophthalmol. (Chicago), 70: 250-2(1963).

Young adult, female RF mice injected intravenously with 0.075-0.10 mg/kg 4-(p-dimethylaminostyryl) quinoline (4M20) developed severe lens opacities. The rapidity of appearance and progression of lens opacities were dose-dependent, the earliest changes being detectable with a slit lamp 87 days after treatment. Early in the development of lens opacification at the 0.10 mg/kg dose level, the initial change was located at the anterior rather than at the posterior pole of the lens, in this respect differing from the opacities observed at the other dose levels and in irradiated mice. In other respects, the 4M20-induced opacities resembled those caused by ionizing radiation. (auth)

3586 THE EFFECT OF ACRYLAMIDE AND OF ITS HYDROGENATED DERIVATIVE ON IRRADIATED BIOLOGICAL SYSTEMS. Yu. P. Kozlov and T. N. Kalabukhova (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 152: 737-9 (Sept. 21, 1963). (In Russian)

The effect of an aqueous solution of acrylamide $CH_2 = CH-CONH_2$ was compared with its hydrogenated derivative, propionic acid amide $CH_3-CH_2-CONH_2$, on the degree of grafting of a polymer to irradiated wheat seeds (Triticum vulgare), on the survival of irradiated diploid yeast cells (Saccharomyces vini, strain of Megri-139B), and on the degree of hemolysis of irradiated human erythrocytes. The acrylamide grafted readily to the irradiated wheat seeds, but propionic acid amide $CH_3-CH_2-CONH_2$ did not polymerize in the presence of the irradiated wheat seeds. Similarly, treatment of irradiated yeast cells with a 1% solution of acrylamide increased the survival of the yeast cells, while treatment with a solution of propionic acid amide decreased the survival of yeast cells as compared to the survival of the control yeast cells. A concentration of 0.03 to 0.25 wt. % of acrylamide in a suspension of human erythrocyte cells given a dose of 80 kr resulted in a resistance to hemolysis after incubation of the cells at 5°C for a period of 24 hours. The propionic acid amide caused a sharp increase in hemolysis on the irradiated and unirradiated erythrocytes. It is concluded that an unsaturated, low-molecular-weight substance which is readily polymerized can react with free radicals which are formed as a result of irradiation. (TTT)

3587 CONTIBUTIONS TO THE STUDY OF IMMEDIATE AND EARLY X-RAY REACTIONS WITH REGARD TO CHEMOPROTECTION. VIII. X-RAY-INDUCED LIBERATION OF HISTAMINE FROM THE ISOLATED RAT'S UTERUS. T. S. Veninga and J. E. DeBoer (Univ. of Groningen, Netherlands). Intern. J. Radiation Biol., 6: 501-5 (June 1963).

Isolated suspended uterine horns of the rat show a leakage of histamine into their bathing fluid. The leakage is increased by 50 kv x-irradiation in doses of 1000 r. Such increase is suggested to be due to liberation of the bioamine from its storage sites. The phenomenon is comparable to that found for serotonin and catecholamines. (auth)

3588 EFFECT OF PROGRESSIVE CHANGES IN BODY TEMPERATURE OF RATS ON TISSUE OXYGEN-TENSIONS, IN RELATION TO RADIOSENSITIVITY. Dana Jamieson and H. A. S. Van Den Frenk (Cancer Inst. Board, Melbourne). Intern. J. Radiation Biol., 6: 529-40(June 1963).

Oxygen-tensions, measured polarographically in tissues of rats subjected to progressive hypothermia and hyperthermia, are reported. Corresponding radiosensitivity values have been estimated and indicate that both hypothermia (15°C) and hyperthermia (41°C) cause radioprotection due to oxygen effect, with a reduction in radiosensitivity of hemopoietic tissues to ~75 per cent and ~85 per cent of maximum values respectively. The physiological reasons for these findings are discussed. (auth)

3589 PROTECTION OF BARLEY SEEDS FROM X-IRRADIATION BY TYRAMINE AND TRYPTAMINE. C. Gillet (Université, Liège) and Z. M. Bacq. Intern. J. Radiation Biol., 6: 559-63(June 1963). (In French)

Barley seeds dipped during a well-defined time in 8.88 mM solutions of tyramine or tryptamine (HCl) are protected against a single exposure not exceeding 75 kr of soft x rays; the test chosen was the growth of the seedling height. (auth)

3590 ON THE ACTION OF NITRIC OXIDE ON RADIATION-SENSITIVITY. C. Russell and J. V. Davies (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 6: 565-74(June 1963).

The influence of nitric oxide (NO) on the radiation response of the bacteria E. coli and Shigella flexneri is studied. The results show that NO increases the sensitivity of the organism to radiation relative to the sensitivity in NO and that the degree of sensitization depends on the concentration of NO; pretreatment with NO increases subsequent anoxic radiation sensitivity (pretreatment effect); anaerobic-fermentation ability is decreased by pre-treatment with NO. The evidence suggests that the mechanism of action of NO is the same in the two organisms and is not mediated via the respiratory system. It is argued that NO acts, in contrast to O_2, not only at the radiation chemical level, but also by influencing metabolic pathways. (auth)

3591 THE USE OF RADIOCHROMIUM IN THE STUDY OF VIABILITY OF POLYCYTHEMIC BLOOD TRANSFUSED TO PATIENTS WITH CHRONIC LEUKEMIA. V. V. Shishkina and V. D. Sidora (Khar'kov Medical Stomatological Inst. and Khar'kov Inst. of Medical Radiology). Med. Radiol., 8: No. 10, 18-20(Oct. 1963). (In Russian)

By employing a radiochromium procedure to determine erythrocyte life span, the polycythemic blood was demon-

strated to survive in the blood-flow of leukemia patients. (P.C.H.)

3592 ERYTHROCYTE HEMOLYSIS IN RADIATION SICKNESS. M. G. Shitikova (Lenin Inst. of Hematology and Blood Transufsion, USSR). Med. Radiol., 8: No. 10, 20-5 (Oct. 1963). (In Russian)

With the aim of establishing time-periods marking the appearance of manifestations common to the injurious effect of ionizing radiation, investigations were made on the erythrocyte circulation time in irradiated dogs using Cr^{51}. Evidence was obtained proving that the halflife of erythrocytes in the donor's blood stream and of donor's erythrocytes in the blood stream of a healthy recipient fluctuated between 21 and 32 days. In the case of a blood transfusion being made in 2, 3, 4, and 24 hours after irradiation of the donor the $T_{\frac{1}{2}}$ of erythrocytes was reduced to 6–19 days, this testified to the injury sustained by the erythrocytes of irradiated animals during these periods. (auth)

3593 FEATURES PARTICULAR TO THE COURSE OF MYOCARDIAL LESIONS IN RADIATION SICKNESS UNDER CONDITIONS INVOLVING BK-8 BLOOD AND POLYGLUCIN TRANSFUSION. Yu. B. Kofanova (Kiev Research Inst. of Blood Transfusion and Emergency Surgery). Med. Radiol., 8: No. 10, 57-65(Oct. 1963). (In Russian)

The effect produced by the transfusion of blood and of some of its substitutes upon the functional and morphological cardiac changes in experimentally-induced radiation sickness was studied. With repeated blood and polyglucin transfusions, initiated during the latent period of the radiation sickness, when cardiac changes are predominantly of a functional character, histological investigations revealed diminishing permeability of cardiac vessel walls, with no signs of acute myocarditis making their appearance. Histochemical examination discovered the presence of large amounts of glycogen in some myocardial areas with no dystrophic and inflammatory changes. Repeated transfusions also resulted in the reduced permeability of vascular walls, this being paralleled by a gradual disappearance of signs pointing to acute myocarditis. In a series of observations proliferation of connective-tissue cells was ascertained histologically, together with dystrophy and fragmentation of muscular fibers. The glycogen distribution in muscular fibers proved to be unequal. (auth)

3594 THE INFLUENCE OF 2,4-DINITROPHENOL ON THE RADIATION-INDUCED DOMINANT LETHAL FACTORS IN DROSOPHILA MELANOGASTER. J. M. Steger (Universität, Zürich). Oncologia, 15: 247-57(1962). (In German)

The influence of the metabolic inhibitor 2,4-dinitrophenol (DNP) on mutability in the fruit fly was investigated under conditions wherein dominant lethal mutations were increased by irradiation. The 72- and 96-hr larvae, whose testes contain mainly spermatocytes, were given 1000 r of 180-kv x radiation. The descendents of irradiated males mated with nonirradiated females were examined for dominant lethal factors. DNP was either injected into the larvae or added to their diet (corn, sugar, agar) at a concentration of 0.005%. This diet was consumed 4–96 hr before irradiation. The rate of dominant lethal factors was lowered by DNP from 82% to 71–6%, depending on the DNP dose given before radiation. The greatest protective effect of DNP (10.6%) was obtained after it was injected, which was estimated to achieve a 10-fold higher testes DNP concentration than the feeding experiments (which gave a 5.4–9.4% decrease in the mutation rate). The possible mechanisms of the protective effect of DNP are considered in relation to its known action in uncoupling oxidative phosphorylation. DNP by lowering intracellular oxygen content may thus directly prevent secondary radiation reactions, or it may depress the metabolic processes necessary for restoration of altered chromosomes. By depressing the adenosine triphosphate content of the cell it may also impair the healing of genetic material responsible for the lethal factors. (BBB)

3595 RADIOPROTECTIVE PROPERTIES OF DIANABOL. Andrzej Danysz and H. Proniewski (Faculty of Pharmacology, Medical Academy, Bialymstoku, Poland). Polski Tygod. Lekar., 17: 489-90(Mar. 26, 1962). (In Polish)

Since impairment of protein metabolism, especially increased catabolism, plays an important role in the pathogenesis and clinical signs of the radiation sickness, an attempt was made to inhibit protein catabolism by the anabolic steroid Dianabol during the course of irradiation sickness. Experiments were performed in 100 mice and 24 rats. The mice were given 300 r (LD_{50}) doses of x rays and the rats 450 r (LD_{100}). The effects of Dianabol on survival, body weight, and hematologic changes were studied. A protective effect on Dianabol, given by stomach tube in the rats (1 mg/kg body wt) for 7 days preceding and 14 days following irradiation was observed as follows: survival: the mortality in the control group was 100% while in the group of animals given Dianabol none died; protection against the loss of body weight caused by irradiation; and decrease of the postirradiation leukopenia. If given after irradiation Dianabol inhibits only slightly the mortality of rats and has no effect on the loss of body weight and leukopenia. A similar protective effect was achieved in mice. Dianabol (1 mg/kg body wt) given for 7 days preceding and 14 following the irradiation protected the animals against the sequellae of the LD_{50} doses of x rays. Only a slight effect on the survival was noted if Dianabol was given after irradiation. (BBB)

3596 EFFECT OF HYPOTHERMIA ON HEMOPOIESIS IN RADIATION DISEASE. B. Aretinskii. Sb. Rabot. Sverdl. Med. Inst., [No.] 36, 73-86(1962).

Studies were made of the peripheral blood and bone marrow in radiation disease. It was shown that blood regeneration occurred faster under conditions of inhalation of air containing a higher O concentration. Hemopoietic tissues of animals inhaling such air following damaging irradiation absorbed O at a higher rate than tissues of control animals, as shown by the Warburg test. It was concluded that O therapy was an effective means for the restoration of hemopoiesis disturbed by ionizing irradiation. (Ref. Zh., Biol. Khim. 1963)

3597 CONCERNING THE EFFECTS OF AMINOETHYLISOTHIURONIUM (AET) ON THE RADIOINDUCED MUTATION RATES IN DROSOPHILA MELANOGASTER. Heinz Henke, Guenter Hoehne, and Hans A. Kuenkel (Universität, Hamburg). Strahlentherapie, 122: 279-84(Oct. 1963). (In German)

The influence of aminoethylisothiuronium chloride-hydrochloride (AET) on the radiation induced rate of recessive sex linked lethal mutations in Drosophila melanogaster was determined using the Muller-5-method. A significant increase of the radiation-induced mutation rate was observed after the administration of this compound, which is known as a radiation protective substance in regard to somatic damages. However, chemomutagenity did not occur. The sensitizing effect was observed in sperm of different degree of maturity. (auth)

Radiation Hazards and Protection

3598 (TID-19266) IODINE-131 IN FRESH MILK AND HUMAN THYROIDS FOLLOWING A SINGLE DEPOSITION OF NUCLEAR TEST FALLOUT. H. A. Knapp (Division of Biology and Medicine, AEC). June 1, 1963. 120p.

Measurements of fallout pattern, I^{131} levels of open fields and fresh milk, and external γ dose rate were made at various locations from 50 to 400 miles from the detonation of a low yield nuclear device (Small Boy) on a 10 ft wooden tower at the Nevada Test Site on July 14, 1962. Results indicate that the content of I^{131} in fresh milk reached a maximum value within 4 days following deposition of fallout, and thereafter decreased exponentially with a half reduction time of about 5 days. A formula is presented for estimating levels of I^{131} in fresh milk from the external γ dose rate in open fields 24 hr following the detonation. A formula is also presented for use in estimating the I^{131} content of the human thyroid and the resulting internal radiation dose to the thyroid resulting from the daily consumption of fresh milk from cows grazing on pastures on which there has been a single deposition of nuclear test fallout. Thyroid burdens of persons on dairy farms in Utah were calculated from measured levels of I^{131} in milk, and the calculated levels were compared with in vivo measurements of I^{131} burdens. The results are discussed and reasons for uncertainty in the relation between milk levels and γ levels are considered. (C.H.)

3599 RADIOLOGIC TELEVISION—ITS PHYSICAL, PHYSIOLOGICAL, AND PATHOLOGICAL PROBLEMS. M. Noix. Acta Iberica Radiol.-Cancerol., 16: 387-98 (Oct.-Dec. 1961). (In French)

Projection of fluoroscopic images by television to reduce the radiation exposure of patients and radiologists is discussed. (BBB)

3600 PERSPECTIVES IN RADIATION DOSIMETRY. A. S. McLean. Atomics, 16: No. 6, 30; 47-9(Nov.-Dec. 1963).

One of the chief issues in the area of radiation dosimetry is the concept of maximum permissible dose. In an effort to simplify radiation protection, extrapolations from what is known about very large doses were subjected to statistical analyses to yield theories of permissible exposure levels. Two problematic aspects of radiological protection are identified as: adoption of the non-threshold concept and semantic difficulties in communication about radiological protection. Dosimetry techniques, a tribute to progress in radiological physics and biology as well as electronics, should be qualitative in addition to quantitative. Accordingly, physicians are warned against furor therapeutics, and health physicists are urged to view the individual as a person rather than a statistic. Assessment of individual radiation doses requires cautious measurement, judicious interpretation, and a constant awareness of the biological, administrative, and social consequences. (H.M.G.)

3601 A RECENT CASE OF OCCUPATIONAL ACUTE RADIODERMATITIS. R. Degos, J. Delort, and R. Touraine. Bull. Soc. Franc. Dermatol. Syphilig., 68: 810-12 (1961). (In French)

Two cases of acute radiodermatitis in x-ray crystallographers that were reported in 1958 at the Centre d'Études Nucléaires at Saclay were followed in 1961 by a third case described herein. A radiocrystallographer developed erythema and blisters on two fingers over a period of 6 weeks after a 15- to 30-min exposure to x rays during installation and testing of equipment. Lesions were limited to the two fingers exposed and were painful, especially to the touch; the patient had difficulty bending both proximal and distal phalangeal joints. Local hydrocortisone treatment (twice daily applications of ointment containing 3% steroid) provided marked analgesia, and although the blisters gradually healed, erythema and skin tenderness persisted. Keratotic tissue developed on the palmar side of finger tips. However, radiographic and electromyographic examinations on phalangeal bone and muscle revealed no effects. The difficulty of making the Saclay Center authorities accept the radiodermatitis diagnosis is pointed out; acceptance is important so that the patient may benefit from compensation for occupational disease. (BBB)

3602 INVESTIGATION OF THE IRRADIATION OF POPULATIONS THAT HAVE UNDERGONE SYSTEMATIC RADIOLOGIC EXAMINATIONS OF THE THORAX. C. Gernez-Rieux, G. Bonte, M. Gervois, and E. Spy (Hopital Thoracique Albert Calmette, Lille). Bull. Union Intern. Tuberc., 32: 179-95(June 1962). (In French)

An international survey made in 1958, with the Comités Nationaux de Lutte Antituberculeuse, provided a large body of information gathered from Austria, Belgium, Canada, Denmark, France, Great Britain, Japan, Netherlands, Rumania, Switzerland, and Spain, relating to radiation dosages in detection of tuberculosis. It was found that in these countries with the equipment and techniques in use at the time, radiography necessitated a radiation dose of 200–640 mr as measured on the dorsal surface of the thorax, whereas fluoroscopic examination required doses ranging from 700 mr to 15 r, according to technique employed. Gonadal doses were negligible with radiography, and the significant genetic dose for the entire population was estimated to be not over 80 μr in one country where approximately 55 million photofluorographic examinations were made in 1958 in persons under 30 years old. The average bone marrow dose per inhabitant varied from 0.2 to 37 mr in the various countries. Plumonary fluoroscopy exposes the individual to greater somatic and gonadic radiation and, it is suggested, should be eliminated from antituberculosis programs. To reduce patient exposure during thoracic radiology, the following precautions are recommended by the Commission de la Radiologie de l'Union Internationale contre la Tuberculose: use of mirror camera: adoption of higher film sensitivity and improved development techniques; use of higher maximum kilovoltage; establishment of a screen focus distance at less than 1 m; filtration with 3 mm of aluminum; exposure time of less than $\frac{1}{10}$ sec; use of beam-localizing diaphragm and, if necessary, of a lead apron. Chest roentgenography still remains the most effective means for detecting new cases and follow-up examination in tuberculosis, and with adequate safeguards to minimize patient radiation, exposure does not present undue hazards. (BBB)

3603 RADIATION PROTECTION IN DIAGNOSTIC RADIOLOGY. P. A. MacDonald. Can. Nurse, 59: 338-41 (Apr. 1963).

Biologic effects of x rays are discussed and means of limiting patient doses during radiologic procedures are outlined. (BBB)

3604 FACTORS INFLUENCING THE BIOLOGICAL AVAILABILITY OF FALLOUT RADIONUCLIDES FOR ANIMALS AND MAN. C. L. Comar (Cornell Univ., Ithaca, N. Y.). Federation Proc., 22: 1402-9(Nov.-Dec. 1963).

Biological availability of radioiodine and radiostrontium

is considered broadly in terms of relations to radiation exposure. The most important source of I^{131} in human diet is milk. Time at which maximum I^{131} concentration appears in milk is dependent upon ingestion patterns of the animals serving as the milk source and hence, upon condition of the pasture. Usually found in the form of iodide, I^{131} levels in cow's milk are 1% of a daily ingested dose per liter of milk at steady state and about 8% of a single dose in the total milk. Corresponding values for the goat are 40% of a single dose in the total milk and 65% of a daily ingested dose per liter; the very high variability is accounted for by extremes in the levels of milk production of the goats studied. Many chemicals such as iodide or perchlorate when fed to the core will reduce I^{131} levels in milk. However, these chemicals themselves are secreted into milk and may have an effect on the consumer. As a combined effect of thyroid weight and fresh-milk intake, 6 months to 2-year-old children would be expected to have the highest exposure. The body burden of Sr^{90} is governed primarily by the Sr^{90}/CA ratio of the total diet and the comparative retention of these two substances in the body. Plant foods and dairy products are the main contributors of Sr^{90} to the human diet, dairy products generally having a lower Sr^{90}/Ca ratio. From a practical standpoint, the greater the proportion of dietary calcium coming from dairy products as compared to plant foods, the lower will be the Sr^{90}/Ca ratio of the diet. Reduction of Sr^{90} levels in milk by dietary supplementation of stable calcium is possible but for a number of reasons, is not feasible. (H.M.G.)

3605 DISTRIBUTION OF RADIOACTIVITY IN FOODS. Merril Eisenbud (New York Univ., New York). Federation Proc., 22: 1410-14(Nov.-Dec. 1963).

By far the largest fraction of the radioactivity present in foods is due to the naturally radioactive element potassium. The average American ingests about 2300 pC of K^{40} per day and this nuclide, with a half life of more than a billion years, distributes itself through the body, and on the average delivers a dose that is about 20% of the dose received from all natural sources. Other radionuclides that occur naturally in all foods are C^{14}, Ra^{226}, Ra^{228}, and uranium. In some places in the world the radium content of food and water is known to be abnormally high. About half a million people in the Middle West consume water in which the radium content is more than ten times normal. Recent studies in Brazil have shown that foods grown in certain areas known for their high radioactivity contain radium and mesothorium in amounts that are 10-30 times normal. Of the many isotopes produced in fallout, Sr^{90}, Sr^{89}, Cs^{137}, and I^{131} are the most significant insofar as contamination of food is concerned. Beginning with the first test of nuclear weapons, the Sr^{90} content of foods began to increase and records of the amount of Sr^{90} in foods have been maintained by several agencies since 1954. The concentration of this long-lived isotope increased until early 1959 when it began to decline, following the temporary moratorium of weapons testing. American children receive most of their Sr^{90} from fresh milk but this is only because fresh milk happens to be the principal source of dietary calcium. Children who receive their calcium from food other than milk would absorb more Sr^{90} because the cow eliminates much of the Sr^{90} in the process of producing milk. Sr^{89} behaves like Sr^{90} except that it is short-lived and does not accumulate. Cs^{137} is also long-lived, has characteristics somewhat like potassium, but does not accumulate in foods to the same extent as Sr^{90} because it tends to be locked into the soils in such a manner as to be unavailable to plants. During periods of weapons testing the amounts of radioiodine (I^{131}) in milk exceeds that of any other radioisotope. Although traces of this nuclide may be found in other fresh foods, the amounts are insignificant compared to that observed in cow's milk and to a lesser extent in cottage cheese. (auth)

3606 HEALTH HAZARDS FROM FALLOUT. Hardin B. Jones (Univ. of California, Berkeley). Federation Proc., 22: 1415-17(Nov.-Dec. 1963).

Previously adopted threshold concepts in the setting of standards for radiation exposure were replaced in recent years by the concept of proportionality. While there is evidence that there is some repair of radiation damage, some lasting increase in risk appears to persist for each increment of exposure to environmental radiation. Extrapolation of experimental data from high levels of exposure to very low levels indicates that the accumulated human exposure over a lifetime accounts for no more than 10% of the observed mutation rate, the observed incidence of cancer, or of aging. In considering hazards from radioactivity in the food chain, it should be noted that fallout effects are less than one-tenth the estimated very rare effects of natural radiation. (H.M.G.)

3607 COUNTERMEASURES AGAINST RADIONUCLIDES IN FOODS. Merrill S. Read (National Dairy Council, Chicago). Federation Proc., 22: 1418-23(Nov.-Dec. 1963).

Research pertaining to minimizing the effects of fallout in food is reviewed. The first line of defense is preventing the radionuclides in the soil from entering plants. The United States Department of Agriculture suggests procedures such as deep plowing, removal of contaminated soil, removal of radionuclides from the soil by selective planting, and prevention of uptake by selective planting. The second line of defense against fallout is the animal itself. Methods of preventing entry of dietary radionuclides into the animal are pointed out. Removal of fallout from foods is considered. It is suggested that normal processing often appreciably reduces fallout contamination. Dietary substitution, storage, and use of ion-exchange resins are other procedures for food decontamination. Several techniques are considered for removal of Sr^{90} and I^{131} once these nuclides are in the human body. Intestinal-binding agents eliminate Sr^{90} hazards, and administration of stable iodine blocks uptake of I^{131}. The philosophy of countermeasure application is discussed. (H.M.G.)

3608 THE FATE OF RADIOIODINE APPLIED TO HUMAN SKIN. Joan Harrison (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 9: 993-1000(Oct. 1963).

The extent to which radioiodine is absorbed through human skin has been studied under conditions which might be present after reactor accidents. The skin was exposed to aqueous solutions of KI^{131}, aqueous solutions of I_2^{131} and the gaseous I_2^{131}. Although skin is a good barrier to small quantities of radioiodine, some activity is absorbed which could lead to a significant body burden from this type of exposure. For aqueous I^{131} the absorption was 0.008 per cent per cm^2/hr and, for gaseous I^{131}, it was possibly ten times greater. With chemical irritation of the skin from stable I_2 the absorption was greatly increased. (auth)

3609 STUDIES OF K^{40} AND Cs^{137} LEVELS IN MINERS. W. T. Ulmer (Bergbau-Berufsgenossenschaft, Bochum, Ger.), R. Nicolas, H. Muth, E. Oberhausen, and Ch. Onstead. Intern. Arch. Gewerbepathol. Gewerbehyg., 19: 571-80(Nov. 1962). (In German)

Whole-body counts of K^{40} and Cs^{137} in 139 coal miners and 30 retired uranium miners were compared to those of nor-

mal individuals. In terms of g K/kg body wt, the experimental: normal ratio for the total of 169 miners (average age, 41.4 yr) was 1.038, for the coal miners alone (average age, 42 yr) 1.025, and for the uranium miners (average age, 38 yr) 1.099. In terms of $\mu\mu$C Cs^{137}/kg body wt the experimental:normal ratios for these groups were 0.882, 0.873, and 0.925, respectively. When these ratios were calculated for the miners on the basis of the presence or absence of silicosis, the K ratios amounted to 1.025 for silicosis-free miners (average age, 41.2 yr), 1.059 for miners invalided by silicosis (average age, 57.9 yr), and 1.034 for miners with early silicosis (average age, 29.4 yr). The corresponding ratios for Cs^{137} were 0.853, 0.885, 0.936. These differences are not considered to be statistically significant. When the miners were grouped according to mine location the range of K ratios was 1.015-1.035 and the Cs^{137} ratio range was 0.742-0.913. The ratios are compared to published K concentration of human tissues. It is concluded that the differences of K and Cs^{137} concentrations in the miners as compared to normal persons do not indicate a significant radiation hazard. (BBB)

3610 FURTHER STUDIES OF RADIOACTIVE STRONTIUM AND CESIUM IN AGRICULTURAL CROPS AFTER DIRECT CONTAMINATION. L. J. Middleton and Helen M. Squire (Agricultural Research Council Radiobiological Lab., Wantage, Berks, Eng.). Intern. J. Radiation Biol., 6: 549-58(June 1963).

Investigations have continued on the extent to which Sr^{89} and Cs^{137} are transferred to the edible parts of cabbage and potato after aerial contamination at various times in the growing season. Significant trends in the concentration of Sr^{89} and Cs^{137} in the hearts of cabbages and Cs^{137} in potato tubers were observed with maximum values after contamination in the middle of the season. A similar trend in the concentrations of Sr^{89} in potato tubers was suggested, but no significant differences could be established. The range of concentrations was of the same order as those found in previous years. The present and earlier results have been used to assess the relationships in the field between the deposition of Sr^{90} and Cs^{137} and their concentration in crops. These relationships show, at least for wheat and potatoes, reasonable agreement with those deduced from surveys of Sr^{90} and Cs^{137} in foodstuffs resulting from the worldwide dissemination of fall-out from nuclear weapons. (auth)

3611 DO'S AND DON'TS OF X RAYS. M. E. Howard (Christian Medical Coll. Hospital, Ludhiana, India). J. Christian Med. Assoc. India. 37: 245-52(May 1962).

Precautions to be observed in the practice of radiology, particularly in mission hospitals, are reviewed. Handling of radium and protection of personnel exposed during radiotherapy procedures are also discussed. (BBB)

3612 STATISTICAL STUDY OF RADIOACTIVITY IN WRIST WATCHES. H. Enz, R. LeCoultre, and P. Lerch (Institut de Radiophysique Appliquée, Lausanne, Switzerland). J. Suisse Horl., Nos. 1-2, 599-603(1962). (In French)

A study was conducted of 684 Swiss-made watches, ~2 of each model, to find the level of radioactivity of their luminous dials. Four tests were made on each watch: measurement by a thin-window Geiger-Müller counter of β radiation; measurement of γ radiation by means of a NaI-crystal scintillation counter, with a 6% error on highly radioactive watches and more on less active ones; measurement of dosage received from the outer back surface of the watch, by a dosimetric film technique, with ±30% precision; classification as legible in the dark or non-legible in the dark, made by an observer with watch 20 cm from eyes after ½-hr dark adaptation. The results were as follows: determination of the nature of radioactive element in watches showed that two contained Sr^{90} and all others Ra^{226}; amount of radioactivity, as the algebraic mean activity of ordinary watches not containing Sr^{90}, was 0.102 μC of Ra^{226}, and the average of watches manufactured in Switzerland in 1960 was 0.092 μC of Ra^{226}; the total dosage was 1 mrem/hr, that absorbed by the wearer was 0.17 rem/wk at the wrist (cf. max allowable dose 1.5 rem/wk), and 0.001 rem/wk at the eye lens (max allowable dose 0.1 rem/wk). The calculated genetic dose for Switzerland is 75 mrem/generation (30 yr), or 2–3% of natural genetic dose. (BBB)

3613 STUDIES ON THE ENVIRONMENTAL CONTAMINATION WITH CESIUM-137. Noboru Yamagata (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 11: 115-30(July 1962). (In Japanese)

Studies made on environmental contamination with cesium-137 in Japan since 1957 are described, and the main passage route of this radionuclide into man is discussed. Predictions of future levels in diet and in man are given. (auth)

3614 CESIUM-137 IN HUMAN BODY, DEC. 1961-NOV. 1962. Noboru Yamagata and Yumiko Kai (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 11: 191-6(Dec. 1962).

Post mortem samples of human breast muscles collected in Tokyo during December 1961 to November 1962 were analyzed for Cs^{137} and K. Two peaks in monthly averages were observed in the Cs^{137} levels in March and October 1962, the concentrations being 0.201 and 0.156 $\mu\mu$C/g, respectively, as compared to the mean levels of 0.09–0.11 $\mu\mu$C/g. The estimates of total body burden showed 4.3–4.8 m μC on the average for the whole period. (auth)

3615 IODINE-131 IN JAPAN IN 1962. Noboru Yamagata and Kiyoshi Iwashima (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 11: 204-9(Dec. 1962).

Measurements were made on the concentrations of I^{131} in air, leafy vegetables, milk, and human thyroid glands from September to December 1962. The concentration of I^{131} in air showed a maximum of 2.4 $\mu\mu$C/m^3. The average for the whole period was 0.43 $\mu\mu$C/m^3. Spinach samples showed a maximum of 1.9 $\mu\mu$C/g wet tissue, the average being 0.45 $\mu\mu$C/g. Liquid milk from Tokyo showed a maximum level of 200 $\mu\mu$C/l, the monthly averages being 94, 93, 86, and 49 $\mu\mu$C/l in September-December, respectively. Average daily intake of I^{131} through ingestion of leafy vegetables, which were considered the main channel of transmittance of this radionuclide to the human population of Japan, was estimated as 8-26, 13-39, 11-33, and 7-20 $\mu\mu$C in September-December, respectively. The level of I^{131} in human thyroids from 205 persons who died during the period September 10-November 30 in Tokyo was 2.0, 1.1 and 1.8 $\mu\mu$C/g wet tissue on the average in September, October and November, respectively. (auth)

3616 PROCEEDINGS OF THE NORTH CENTRAL EXPERIMENT STATIONS WORKSHOP ON RADIONUCLIDES IN FOODS AND AGRICULTURAL PRODUCTS, FEBRUARY 19-21, 1963, CINCINNATI, OHIO. F. Haghiri and R. R. Johnson, eds. Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 1-145(1963).

Twelve papers were presented. Separate abstracts were prepared for each. (H.M.G.)

For abstracts of individual papers see: 3449, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3624, 3696, 3894, and 3895.

3617 SOURCES OF RADIOACTIVITY IN FOODS. Alfred W. Klement, Jr. (Atomic Energy Commission, Washington, D. C.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 4-8(1963).

Various sources of environmental radioactivity that may affect its accumulation in foods are discussed. Plant roots are one of the most important entry routes of radioactive materials into biological systems. With respect to agriculture radium is usually the most important of the naturally-occurring nuclides, with K^{40} likely being the most abundant natural radionuclide in agricultural soils. Cosmic particles reacting with stable elements in the atmosphere, and to a lesser extent in the soil, are responsible for addition of tritium and C^{14} to the food chain. Undoubtedly, the major source of current concern with regard to radioactivity in foods is debris from nuclear weapons tests. Of the radionuclides produced in nuclear weapons tests, most are short-lived and decay to unmeasurable amounts within the first few hours. Types of fallout generated by a nuclear detonation are relative to the yield of the explosion. Yields of less than 1 megaton primarily contaminate the Troposphere and produce tropospheric fallout. The principle radionuclides of interest in Tropospheric fallout are I^{131}, Sr^{90}, Ba–La^{140}, and Zr^{95}. Weapons with yields in excess of one megaton contaminate both Troposphere and Stratosphere. In the case of Stratospheric fallout, longer-lived nuclides such as Sr^{90}, Cs^{137}, C^{14}, and Pu^{239} become important. Direct-cycle air-cooled reactors and reactor fuel processing plants are examples of industrial operations that release some radioactive debris to the atmosphere. Iodine-131 contamination of milk resulting from the Windscale incident is discussed. Basic methods of radioactive waste disposal are reviewed. (H.M.G.)

3618 RADIOACTIVITY IN FOODS–POULTRY AND ANIMALS IN GENERAL. Homer Patrick (West Virginia Univ., Morgantown, W. Va.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 32-4(1963).

Fission products most commonly considered important in animal foods are Sr^{89}, Sr^{90}, Cs^{137}, Ba^{137}, Ba^{140}, and I^{131}. The two most probable sources from which large amounts of Sr^{89} and Sr^{90} could be obtained are plant and animal products high in calcium. Radio-strontium isotopes, concentrated in the bones and egg shells of meat animals, may be removed prior to slaughter of the animal via feeding either a calcium-deficient diet or a highly calcium-rich diet. Due to confinement of radiostrontium in food products primarily to bone and egg shell, the consumption hazard is small. However, cooking processes may result in a migration of these nuclides to edible portions. Cesium-137 enters the food chain via plant root absorption. The Cs^{137} entering a plant occupies the same molecular position as potassium in the fiber structure but does not react biochemically as a part of the enzyme system. Cesium concentrates in the soft tissues and muscles. Radioisotopes of iodine are predominately concentrated in the thyroid gland, some is excreted in milk. Iodine-129 and I^{131} are not a hazard in meat and eggs. Barium 137–140 is such a poorly absorbed element and so highly complexed in the gut that it probably will not become any great danger. Criteria are drawn for radioactivity determinations in meat and eggs, and basic recommendations are made for formulation of discriminating ratios. (H.M.G.)

3619 STRONTIUM 90 IN U. S. WHEAT AND FLOUR. Joseph Rivera (U. S. Atomic Energy Commission, New York). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 36-40(1963).

A study of the Sr^{90} contamination of wheat and flour was made by the Health and Safety Laboratories (HASL). Samples were obtained from Minnesota crops of 1956, 1957, and 1958. Wheat and milling products from the 1958 crops of nine additional states were obtained and analyzed for Sr^{90} and calcium. Previous experiments showed that strontium derived from the soil is taken up relatively poorly by the berry and tends to concentrate in the bran fraction. Sr^{90}/Ca ratios in U. S. wheat crops were determined for each year between 1958 and 1961. Patent flour was found to contain 10% of the Sr^{90} in wheat. The Sr^{90}/Ca ratio in the flour was about two-fifths that of the wheat. Specific activity ($\mu\mu$C Sr^{90}/mg Sr) measurements in bran layer fractions indicated that the mechanism of contamination was by direct deposition of the outermost tissues of the berry and then some translocations of the Sr^{90} to the inner tissues from which flour is made. From the HASL tri-city diet study it was deduced that from 10 to 20% of the total Sr^{90} was taken in at each of the cities. Sr^{90}/Ca ratio in the total diet was lower than that of wheat products. The significance of this finding for dietary control of Sr^{90} levels is indicated. (H.M.G.)

3620 RADIOACTIVITY IN GRAINS. Philip F. Gustafson (Argonne National Lab., Ill.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 41-8(1963).

Various types of grains were analyzed for Cs^{137} and K^{40} by gamma spectrometry of bulk samples. Samples representing the major grain producing portions of the United States were obtained from the United States Department of Agriculture. The data presented show that the Cs^{137} and Sr^{90} contents of grain are strongly dependent upon the fallout deposition occurring during the growing season and to a lesser extent upon the accumulation of these radionuclides in the soil. Newly deposited fallout products have a 10-fold greater probability of entering the plant and being incorporated into the grain. Hence the importance of foliar uptake or other modes of entry into the plant exclusive of the root uptake is apparent. It is also of interest to note the relative low amounts of Cs^{137} and Sr^{90} present in corn as compared to other cereal products. (H.M.G.)

3621 SURVEY OF RADIOACTIVITY IN FRUITS AND VEGETABLES. Edwin P. Laug (Dept. of Health, Education, and Welfare, Washington, D. C.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 50-7(1963).

Data are presented on Sr^{90} concentration per kilogram of fruit and vegetable raw product. The ordinary mechanical processes in the preparation of human food can be expected to reduce the intake of Sr^{90} materially. Furthermore, the concentrations per kilogram of any food must be evaluated in terms of the average daily amount eaten. When this is done the orientation offered by the Federal Radiation Council becomes very useful. (auth)

3622 CURRENT RESEARCH ON RADIOACTIVE CONTAMINATION OF SOILS AND PLANTS. Alfred W. Klement, Jr. (U. S. Atomic Energy Commission, Washington, D. C.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 59-63(1963).

Research dealing with the interrelations of soils and plants that control the absorption of radionuclides by plants is reviewed. Descriptions are given of AEC-sponsored programs on radioactive contamination of plants and soils. (H.M.G.)

3623 GUIDELINES FOR TOLERANCE LEVELS OF RADIONUCLIDES IN MAN. Donald R. Chadwick (U. S. Public Health Service, Washington, D. C.) and Conrad P. Straub. Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 65-80(1963).

Guidelines for tolerance levels of radionuclides in man are discussed in relation to terminology; factors involved in the establishment of concentration values for foods, air, and water and basis for the graded approach to evaluation of environmental radioactivity. (H.M.G.)

3624 EFFECT OF FARM PRACTICES ON RADIONUCLIDES IN MILK. Conrad P. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati) and Jack H. Fooks. Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 108-20(1963).

Research studies on the effects of farming practices on the radionuclide content of milk are reviewed. Surveys by the Pasteurized Milk Network operated by the Division of Radiological Health yielded considerable information on the gross farming practice picture, particularly with respect to whether the animals were on pasture or on a stored feed in a sheltered environment. Data presented are sufficiently convincing to demonstrate a cause and effect relation between certain farming practices, particularly pasture versus stored (uncontaminated) feeding on radionuclide levels in milk and the effect of increasing soil fertility in decreasing output of radionuclides in fluid milk. These findings demonstrate the feasibility of this approach for reducing radionuclide levels. (H.M.G.)

3625 NUTRITION IN RELATION TO PROBLEMS OF RADIOACTIVITY. Gilbert B. Forbes (Univ. of Rochester, N. Y.). Pediat. Clin. North Am., 9: 1009-24(Nov. 1962).

Basic principles relating to radioisotopes are explained for the physician, preliminary to a discussion of the significance of fallout radionuclides in pediatric nutrition. After a consideration of factors that bear on the amount and composition of fallout products, and those factors that concern their metabolism by the body, it is concluded that for practical purposes only the following isotopes are of biological significance: Sr^{89}, Sr^{90}, I^{131}, and Cs^{137}. Other factors that govern the pattern of fallout and that bear on the possible biological hazard are discussed: amounts produced by nuclear bombs, physical half life, rate and location of terrestrial deposition, efficiency of transfer through the food chain to man, absorption and retention by the body, and distribution within the body. Dietary surveys reveal that the intake of Sr^{90}, expressed on a per g Ca basis, does not differ appreciably among infants, teenagers, and adults. The average value is about 15 $\mu\mu$C/g Ca, with values somewhat lower on the West coast than in the East. Evaporated milks have about the same content as that of fluid whole milk, and the content of prepared infant foods does not differ significantly from that of analogous foods eaten by adults. Instant tea and coffee have a high content of Sr^{90} and Cs^{137}, and many other fission products, such as Zr^{95} and Ru^{106}. Whole-wheat flour has more Sr^{90} by a factor of four than does white flour; the content of leafy vegetables exceeds that of root vegetables by a factor of 10. Fish have a low content because of the large dilution of fallout by water. Human milk contains only about $^1/_{10}$ as much Sr^{90}/g Ca as the mother's diet. Thus the lactating woman provides a discrimination factor, from diet to milk, just as does the cow. Soybean formulas for infants contain only $^1/_4$ as much Sr^{90} as powdered milk formulas, due to addition of uncontaminated Ca during processing. Strontium-90 content of milk collected in the New York City Area during the past seven years is discussed. Although a large share of the dietary Sr^{90} comes from dairy products, total intake is higher in populations whose dietary Ca is largely from nonmilk sources, due to the discrimination factor provided by the cow. Thus, skeletons of rice-eating peoples accumulate 4 times as much isotope as those of milk-drinkers. Measures to reduce fallout exposure are discussed. Washing, peeling, shelling, or removal of the outer leaves of fruits and vegetables will remove much of the external contamination. A portion of the I^{131} of milk can be removed by aeration. A 90% reduction in other nuclides can be achieved by treatment with ion-exchange resins. Some recently marketed infant formula products contain amounts of Sr^{90} too small to be detected. For short-lived isotopes, such as I^{131}, storage allows for dissipation of much activity. With the exception of thyroid blocking with KI, the magnitude of the response to various proposed prophylactic procedures is only 2- to 4-fold; some of them are inherently hazardous, and some are not applicable on a wide scale to man. At present it may be possible to reduce the fission product intake of infants to a certain extent (perhaps by a factor of 5 to 10) by means presently available. The feasibility of accomplishing the same objective in older children on a wide scale is less certain. The remote possibility of introducing new health hazards by the use of procedures aimed at decontamination of foods or diminishing the body burden should always be considered, particularly if large-scale operations are contemplated. It is concluded that the amount of radiation contributed by fallout from weapons testing is only a small fraction of that delivered to the population by other man-made sources. The biological risk from fallout is an exceedingly small one, but is nevertheless of concern to the pediatrician, since children have a much longer life expectancy and will contribute more to the future genetic burden, whatever this may be, than the adult. (BBB)

3626 THE PHYSICIAN AND ENVIRONMENTAL RADIATION HAZARDS. Eric Reiss and Malcolm L. Peterson (Washington Univ., St. Louis). Pediat. Clin. North Am., 10: 449-68(May 1963).

Genetic and somatic effects of radiation in children are discussed, particularly with respect to medical and fallout radiation sources. Only a small fraction of naturally occurring mutations can be attributed to background radiation (~0.1 rad/yr). The dosage required to double the mutation rate in man is estimated to be between 10 and 100 rad, with 15 to 30 rad as the most probable value for acute exposure and 100 rad for chronic exposure; however, physicians treating young patients have a special obligation to keep gonadal exposure to a minimum, since even small changes of the mutation rate have serious long-range biologic and social implications. It is pointed out that the problem of radioinduced mutations is so important that ill-advised statements concerning negligible radiation exposure should be disregarded. The Committee on Environmental Hazards of the American Academy of Pediatrics has recently issued a statement that assesses the genetic effects of fallout in Japanese atomic bomb survivors as nonexistent. It is suggested that this statement is erroneous and embodies a misleading limitation. A highly probable genetic effect has, in fact, been observed in exposed Japanese populations; namely, a change in the sex ratio of children of irradiated parents in the direction of fewer males. The misleading aspect of the Academy's report also ignores the recessive character of most radioinduced mutations. These would not be readily detected in the first generation, but would become apparent in future generations when homozygotes are produced. The principal sources of radiation exposure are listed and their relative contributions to hereditary effects are indicated. The order of magnitude of radiation doses associated with various diagnostic studies is tabulated. The average radiologic examination of abdomen and colon, including the fluoroscopy, contributes a gonadal dose of 2 rad, or ~20 times

yearly background exposure. Relative importance of various fallout radionuclides in contributing to the exposure of children is assessed. Cesium-137 and C^{14} contribute the largest genetically significant dose; since the Sr isotopes are concentrated in bone and I^{131} in thyroid, they contribute little radioactivity to the gonads. A survey of radiation doses attributable to fallout from weapons testing in 1954–61 is given. Carbon-14 contributes a large fraction of the radiation dose to gonads as well as to other tissues. Its effect is protracted; only 10% of the total dose attributable to it will be biologically effective by the year 2000. By contrast, all the Cs^{137} from past weapons testing is expected to have exerted its activity by that time. Estimates of genetic damage resulting from C^{14} released during weapons testing depend on whether only the present generation or all future generations are considered. Radioinduced carcinogenesis in children is considered, especially with reference to thyroid cancer for x rays and I^{131}. (BBB)

3627 A STUDY ON THE PHYSIOLOGICAL ACTIVITY OF CERTAIN MUSCULAR RELAXANTS IN RADIATION SICKNESS. T. Giurgiu, T. Safta, and P. Atanasov. Rev. Sanit. Mil., 59: 547-51(May-June 1963).

The results of a quantitative evaluation of the curative value of d. chlorhydrotubocurarine (Burroughs Wellcome Tubarine) and galamine triiodoethylate (Specia Flaxedil) in acute radiation sickness was made based on the head-drop test in rabbits exposed to ionizing radiation (400 r total). The curarizing action of Tubarine was slightly lower in irradiated than in non-irradiated animals, about 7% average, while that of Flaxedil was unchanged. (TCO)

3628 OBSERVATIONS ON DIAGNOSTIC ACTIVITIES AND PRACTICES IN TUBERCULOSIS DISPENSARIES AND RADIATION PROTECTION. Karlheinz Hopf (Tuberculosis Dispensary, Querfurt, Ger.). Tuberkulozis, 14: 271-3(Sept. 1961). (In Hungarian)

A comparison of the number of registered tuberculous patients in the German Democratic Republic and Hungary showed that in 1956 Hungary recorded a rate of 1.33% patients with active tuberculosis, whereas Germany showed 1.22%. The difference in these percentages indicates that different standards were applied in classifying patients as inactive, chronic-active, or infectuous tuberculotics. This study showed that some patients were carried on the records as tuberculotics who have long been cured and should have been classified as inactive. The practice of annual chest x-ray examination for the entire population for the purpose of detecting new cases of tuberculosis is discussed (an accepted practice in the German Democratic Republic). The possible hazards to humans from such radiation exposure are considered. It is concluded that chest x rays carried out by properly trained personnel do not constitute any particular hazard to the patient provided proper screens are used and fluoroscopic exposure is not longer than 30 sec. Testimony of expert roentgenologists is cited which maintains that the doses received in a series of routine chest x rays are no more than the average natural radiation dose received by an individual. This method, therefore, should not be discarded as an effective method for the detection of new, active cases of tuberculosis. (BBB)

3629 CONTAMINATION OF FOODSTUFFS BY ATOMIC WEAPON TESTS AND ITS BIOLOGICAL SIGNIFICANCE. W. Scheurmann (Technische Hochschule, Hanover). Z. Ernaehrungswiss., 2: 124-40(May 1962). (In German)

As a result of more than 200 atomic explosions over the period 1945–60 ground concentrations of Sr^{90} have risen as high as 14 mC/km^2 and Cs^{137} concentrations to almost 150 mC/km^2. Values of Sr^{90} observed in some milk samples exceed 40 $\mu\mu$C Sr^{90}/l, but this varies with the season. In Germany the average atmospheric specific activity of mixed fission products and Sr^{90} in air varies closely with the frequency of weapons tests, but the soil concentration of Sr^{90} is progressively cumulative and reached a value of over 20 mC/km^2 in 1960. Because these radionuclides concentrate within the soil surface layers, they are readily incorporated into food crops. In Germany for the period 1958–9 the average daily individual intake of Sr^{90} from milk, grains, vegetables, and fruit was 3.2, 1.7, 1.1, and 1.0 $\mu\mu$C. It is estimated that in Germany in 1960 the maximum Sr^{90}/Ca ratios in bone of age groups 0–5, 5–20, and 20+ yr were 3.2, 2.0, and 0.6 (as 10^{-6} μC/g Ca) and amount to 1:35, 1:70, and 1:200 of the maximum permissible concentration (MPC) established by the International Committee on Radiation Protection (ICRP). The results of surveys of soil contamination by radioactive isotopes and their incorporation into foodstuffs are discussed as the basis for evaluation of their possible hazard to man. (BBB)

3630 BIOPHYSICAL STUDIES OF POSSIBLE RADIATION INJURY IN MAN. H. Muth (Universität des Saarlandes, Homburg, Ger.). Zentr. Arbeitsmed. Arbeitsschutz, 12: 181-7(Aug. 1962). (In German)

Methods and apparatus for detection of γ radiation from Ra^{226} and related radionuclides incorporated by humans are discussed. Equipment characteristics of the Los Alamos whole-body counter and the walk-in human counter for detection of Ra^{226}, Th^{228}, Cs^{137}, and K^{40} are presented. For Ra^{226} and other radionuclides the detection limit for these counters is related to the body concentration of K^{40}. Effects of the time and mode of incorporation of radionuclides on the estimation of the radioactivity deposited by excreta are discussed. Results of whole-body measurements on 13 industrial radium workers showed that four exceeded the maximum permissible level (MPL) for Ra^{226} and Ra^{228} established by the International Commission on Radiological Protection (ICRP). In one case the γ spectrum suggested the presence of an additional radionuclide, which was confirmed by urine measurements and identified as Cs^{137}. Eight months later the radium content of this patient's urine was unchanged. The Cs^{137} deposited was judged to be reduced, so that the Cs^{137} biologic half-value time could be estimated to be 144 days, in close agreement with the ICRP values of 140 days. Additional measurements in eight patients previously treated with Thorotrast indicated Th^{228} depositions as much as 50-fold the permissible limit and as much as 20-fold for Ra^{228}. Measurements of Po^{210} in urine from a uranium miner exposed for four yr indicated a radon concentration 430 times greater than the MPL value established by the ICRP. These studies are continuing, and suggest that in some cases internally deposited radionuclides can be sources of possible radiation damage potentially far greater than external radiation may be. (BBB)

Radiotherapy and Radiodiagnosis

3631 (AED-C-10-01) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. NUKLEARMEDIZIN. RADIONUKLIDE IN DER DIAGNOSTIK VON NIEREN-, LEBER-, MILZ- UND PANKREASKRANKHEITEN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Radionuclides in the

Diagnosis of Kidney, Liver, Spleen and Pancreas Diseases. Bibliographic Compilation). (Berlin. Freie Universitat). July 1963. 107p.

Two hundred and eighty-two references on radionuclides in the diagnosis of kidney, liver, spleen, and pancreas diseases are presented. Author, subject, and radioisotope indexes are included. (M.C.G.)

3632 RADIOISOTOPES IN THERAPY. F. Gavosto. Aggiorn. Clinicoterap., 4: 1-53(Jan. 1963). (In Italian)

Effects of ionizing radiations at the cellular and human levels are reviewed in relation to various medical applications of radioisotopes. (BBB)

3633 (JPRS-22119) THE RESULTS OF DOSIMETRIC MEASUREMENTS IN THERAPEUTIC WORK WITH RADIOACTIVE IODINE. G. A. Sheshina, N. S. Rastaturov, V. G. Gerasimyak, and P. S. Pivanova. Translated from Med. Radiol., 8: No. 9, 44-8(1963). 6p. (OTS-63-41277)

A determination of the doses received by a laboratory technician working with radioactive iodine was undertaken with the intention of working out basic recommendations for load standards of personnel working with I^{131}. Using an RM-1 dosimeter, measurements were made at the time of pouring and administering I^{131} to 53 patients; and during the counting of the pulses from the thyroid gland in 117 patients, some of whom took I^{131} on the day the count was made, some who took it the night before, and some several days previously. The activity of each therapeutic portion was within limits of 3–50 millicuries, being on the average of 4.1 millicuries per patient. From the data it was concluded that the laboratory technician, under the working conditions used, would receive from therapeutic procedures on six patients and functional examinations on eight patients a dose close to the permissible dose of 16 mr per day. (H.M.G.)

3634 SOME NEW PORTABLE RADIOACTIVE SOURCES FOR DIAGNOSTIC RADIOGRAPHY. Kenneth L. Krabbenhoft (Harper Hospital, Detroit) and Farno L. Green. Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 1123-42(Dec. 1963).

Radiography with portable radioactive isotope sources producing acceptable diagnostic quality is reported. Of particular importance is the experience gained in chest radiography. Five radioisotopes (Sm^{153}, Gd^{153}, Yb^{169}, Tm^{170}, and Lu^{177}) were evaluated. Numerous anatomic parts in addition to the chest were examined. In order to judge the diagnostic accuracy of isotope radiography, comparisons were made with conventional roentgenographic studies. Radioactive sources used for radiography from 1948 to 1963 are tabulated. (P.C.H.)

3635 SOME CONSIDERATIONS ON RADIATION TREATMENT OF MALIGNANT MELANOMAS OF THE FACE AND NECK. F. Baclesse (Foundation Curie, Paris). Ann. Chir. Plastique, 7: 123-34(June 1962). (In French)

Tests of a radiosensitizing substance, cesium eosinate, were made in the x-ray treatment of 46 cases of malignant melanoma of the orbital region and face and in 4 cases of melanoma of the neck, all verified histologically. Irradiation of lesions of the neck in the absence of the radiosensitizer resulted in rapid failures due to metastases via the blood, and in the 4 latter cases lymph nodes were invaded. However, localized lesions on the face and especially the orbital region responded more favorably and over a longer period of time. Radiation treatment averaged 12,000 r of 200-kv x rays fractionated over a period of 3 to 8 weeks. The nontoxic sensitizing agent cesium eosinate was used in some cases with more favorable results. Injections were given into the tumor itself, which had the disadvantage of being very painful. This dye does not depress hematopoietic function and is fixed selectively in the cytoplasm of the cells. It is eliminated in urine and has no cumulative toxicity. With the use of cesium eosinate, it was possible to reduce the radiation dose to 4500–7000 r. It was injected in volumes of 0.5 to 2 ml as a 6% solution 30 min before irradiation. It presumably acts locally or even intracellularly. Surgical treatment is recommended for lymph adenopathy, following metastases. (BBB)

3636 TECHNIQUES OF ENDO- AND PLESIO-CURIETHERAPY WITH ARTIFICIAL RADIOACTIVE ELEMENTS IN OTORHINOLARYNGOLOGY. B. Pierquin and D. Chassagne (Institut Gustave Roussy, Centre Clinique et Therapeutique, Paris). Ann. Oto-Laryngol., 79: 413-20 (June 1962). (In French)

Characteristics of various isotopes, their advantages and disadvantages in different types of radiotherapy, and protective measures to be employed in their application are discussed. The great importance of radioisotope therapy in otorhinolaryngology necessitates development of recommendations for their systematic use in treating cancers of the oral region. Advantages of the artificial elements are indicated, and criteria for choice element are discussed. The choice recommended for routine use is Au^{198} and Ir^{192}. Both elements may be used in the irradiating needle technique: a $^4/_{10}$-mm thickness of Au^{198} (or $^3/_{10}$ mm of Ir^{192}) is encased in $^1/_{10}$ mm of Pt, with a length of 3-5 cm, and an outer casing of stainless steel with an exterior dia of 1.8 mm. This method limits exposure of the operator to several minutes, i.e., 30-40% of application time does not involve handling radioactive material. In the plastic tube technique described, Ir^{192} wire $^1/_{10}$ mm in dia is encased in Pt $^1/_{10}$ mm thick plus a small ($^8/_{10}$-mm outer dia) inner tubing of Nylon and an outer larger ($^{16}/_{10}$-mm outer dia) tubing with metal knobs at each end. This method necessitates operator exposure for only 10-20% of the application time. The irradiating needle technique is recommended for small tumors, e.g. in mouth, tip of the tongue, inner surface of cheeks, tonsils and soft palate, dorsal surface of oropharynx, or nerve endings. The plastic tube technique is suggested for extensive tumors on the floor of the mouth, base of the tongue and vallecula, hypopharynx, large glandular cancers, and those of the sinuses and nasal fossa. (BBB)

3637 PRELIMINARY NOTE ON THE CUTANEOUS EFFECTS OF CESIUM THERAPY. P.-Y. Castelain and R. Amalric. Bull. Soc. Franc. Dermatol. Syphilig., 68: 719-23(1961). (In French)

The energy of Cs^{137} γ is comparable to that of Co^{60}, far exceeds that of the other usual forms of radiation, and provides the following properties useful for radiotherapy: relatively high effectiveness at greater tissue depth; homogenous absorption by the tissues; decrease in total dose absorbed by the organism; and relatively low skin doses. Cesium-137 (like Co^{60}) does not cause burns on the skin surface, and remains almost 100% effective at a level 1.5 mm below the skin surface (4.4 mm for Co^{60}). Advantages and disadvantages of cesium-137 therapy are indicated. (H.M.G.)

3638 HEALTH PHYSICS ASPECTS OF IRRADIATION OF LARGE ANIMALS AND HUMAN BEINGS WITH CURIE QUANTITIES OF INTERNALLY ADMINISTERED ISOTOPES. Graham M. Hairr and William D. Loughman (Univ. of California, Berkeley). Health Phys., 9: 987-92 (Oct. 1963). (UCRL-10215(Rev.))

Total-body irradiation techniques using massive doses of chelated Y^{90} administered intravenously in dogs, monkeys

and man for the selective destruction of lymphatic tissue have been developed by biomedical research personnel at Lawrence Radiation Laboratory, Berkeley. Purchase cost and assurance of purity necessitate Y^{90} production at the site from a multicurie Sr^{90} source. Health physics problems included design and construction of shielded and remotely operated Y^{90} extraction equipment, equipment for preliminary animal experimentation, multi-purpose containers for efficient and safe utilization of curie quantities of beta emitters, enclosures for dogs and monkeys during isotope infusion in the hundreds of mc range, and enclosures for long-term maintenance of these animals. Provision was made for simple decontamination and waste processing. An enclosure was designed to comfortably house a human patient and the medical equipment for his treatment. This enclosure provides adequate shielding for the attending medical team, yet permits rapid access in case of a medical emergency. Methods were also developed to prevent spread of radioactive contamination following transfer of the patient to a pressurized reverse isolation hospital room. (auth)

3639 ANTICANCEROUS CHEMOTHERAPY AND RADIOSENSITIZATION. H. Maisin (Institut du Cancer, Louvain, Belg.). J. Belge. Radiol., 46: 391-426(1963). (In French)

Radiosensitization with antimitotics or antimetabolites is the occurrence of a synergic action, obtained by the simultaneous use of these drugs with ionizing radiations. Radiosensitization occurs also when radiosensitivity reappears in a tumor after its treatment with antimitotic and antimetabolitic drugs. The various drugs, clinically or experimentally used as radiosensitizing agents, are enumerated. The mechanism of radiosensitization is considered. Radiations and antimitotic or antimetabolitic drugs do not act at the same moment in the mitotic cycle, the drugs generally acting during the intermitotic phase. The administration and the dosage of the drugs are analyzed in various hematopoietic and solid tumors. It is suggested that these treatments should be reserved to cases where conventional radiotherapy is no longer effective. Excellent symptomatic effects may be obtained by these treatments, but the life of the patient is generally shortened as these drugs have a destructive effect not only on the tumor but also on the hematopoietic and reticulo-endothelial cells. Thus the patient's normal immunity against his own tumor is impaired. (auth)

3640 THE TREATMENT OF RADIATION NECROSIS WITH RADON OINTMENT. C. C. Anderson. J. Coll. Radiologists Australasia, 4: 104-5(Dec. 1960).

Use of a radioactive ointment for topical treatment of small ulcers resulting from radiation burns of the skin is described. Radon gas is soluble in water and alcohol and can be readily absorbed by hydrocarbons and fatty substances. It is this property which allows the employment of its α radiation in the treatment of superficial lesions. The preponderance of α rays in the radiations emitted by radon and their extremely limited penetration allows its employment over even prolonged periods without the development of any unpleasant sequelae. While a concentration of radon of up to 100 esu/cm^3 can be obtained, the more customary strength is 50 esu/cm^3 vaseline. Radon is soluble in vaseline but is not fixed therein, and if the dressing is not covered, the gas will dissipate into the air and dosage is rapidly reduced. For this reason the dressing is covered with a layer impermeable to gas. Radon ointment was used to treat an elderly female who had been over-irradiated following amputation of her breast. Various topical remedies had been used for six months without improvement. It was thought that only extensive surgical resection of the affected skin would bring about healing, but the results from the use of radon ointment in this case were very satisfactory. The ointment was applied directly to the lesion and covered with cellophane to prevent the escape of radon gas, and the edges sealed with Scotch tape. The dressing was removed after 8 hr and reapplied daily. Of 14 patients so treated, every case showed a definite reduction of pain, even though complete healing was not always attained. This method of treatment proved valuable in the relief of acute radionecrosis but of even greater value with those cases where some mechanical injury causes a breakdown in a previously irradiated area. (BBB)

3641 SECONDARY AMENORRHEA AFTER RADIOTHERAPY FOR SACROILIAC SARCOMA. RE-ESTABLISHMENT OF OVULATION AFTER THREE YEARS OF TREATMENT BY GONADOTROPINS. SUBSEQUENT PREGNANCY. M. Gaudefroy and J. Bera. J. Sci. Med. Lille, 80: 292-5(June-July 1962). (In French)

The case is described of a woman who at age 13 developed lumbar pains that increased over a 4-yr period. Complete radiologic examinations then revealed a sacroiliac decalcification disorder, but no other areas were involved. When the patient was 18, appendectomy gave an opportunity for surgical exploration which revealed an osteogenic sarcoma in the sacroiliac region. Postoperative irradiation was applied in fractionated doses of 50 r for 30-min sessions to a total of 1500 r. More intensive radiotherapy followed: 250 r at a time, up to a total of 4000 r in each of 2 fields; this was higher than the estimated 3000-r sterilization dose. Within a year, complete amenorrhea ensued. Several courses of estrogenic treatment were attempted, each producing only temporary bleeding. Then a 3-stage course of treatment with gonadotropins was begun 3 yr later over a 4-yr period. The first phase was establishment of artificial menstrual cycles, by estrogens, to develop endometrical tissue. The 2nd stage consisted of a combination of estrogens with small doses of gonadotropins. The 3rd stage consisted of gonadotropin treatment alone, in several forms (to avoid development of antihormones from immunologic reactions) to induce spontaneous ovulation. This was attained 8 yr after beginning treatment when the patient gave birth to a normal infant. The following points are emphasized: total cure of the sarcoma was produced by radiation, with slight structural modification; despite an overall dose of 9500 r, which theoretically should have destroyed reproductive function, re-establishment of almost normal function was attained; it is probable that gonadotropin therapy alone was responsible for restoration of ovulation because of the long time over which it was given. (BBB)

3642 RADIOISOTOPE PHOTOSCANNING OF THE KIDNEYS IN UROLOGIC DISEASE. M. B. Cohen, R. O. Pearman, M. M. Mims, and W. Blahd. J. Urol., 89: 360-5 (Mar. 1963).

Principles and applications of the technique are discussed. (BBB)

3643 DIAGNOSTIC USES OF RADIOISOTOPES. J. Setoain Quinquer and F. M. Domenech Torne. Med. Clin. (Barcelona), 39: 447-52(Dec. 1962). (In Spanish)

3644 DERMAL CHANGES IN THE REGION OF EXPOSURE FIELDS SUPERVENING AT REMOTE DATES FOLLOWING X- AND GAMMA-RAY THERAPY OF MALIGNANT TUMORS. V. A. Rakhmanov, L. D. Lindenbraten, G. F. Romanenko, N. S. Kazantseva, and L. G. Sheremeteva

(Sechenov Medical Inst., Moscow). Med. Radiol., 8: No. 10, 43-7(Oct. 1963). (In Russian)

Studies were made on the condition of the skin in the region of exposure fields at remote periods following distant radiation therapy of malignant tumors of mammary glands, the uterus, and the ovaries. In 21 female-patients morphological alterations and elevated skin temperature were recorded after a lapse of 2.5–9 years since dispensation of the x-ray therapy. In some patients a perverted nature and changed rate of dermovascular responces to pain and pharmacodynamic irritants were noted. In 30 female-patients the skin temperature in the area of fields formerly exposed to gamma-therapy by radiocobalt was, as a rule, normal after expiration of 3–7 years. Morphological alterations of slight degree were discovered in 25 patients, complete falling out of the hair was observed in 5 cases, sclerosing of the skin and of the subcutaneous fatty cellular tissue in 6, while the development of teleangioectasy was recorded in 5 instances. (auth)

3645 LATE RADIATION INJURIES OF BONES IN ROENTGENOTHERAPY. I. I. Fedorov and N. P. Ushakov (Chernovits Medical Inst., USSR). Med. Radiol., 8: No. 10, 48-50(Oct. 1963). (In Russian)

Two cases of late radiation injuries of bones following roentgenotherapy are described. The first case was a compression fracture of the left femur collar occurring one year after roentgenotherapy effected for carcinoma of the uterine body of the stage. Five years thereafter there occurred a fracture of the right anterior pelvic bone and, after a lapse of 9 more years a fracture of the right femur. In the second case the female-patient underwent a treatment course by combined radiation therapy for carcinoma of the uterine cervix of the II stage. At the expiration of 7 years the patient suffered an oblique fracture of the right pubic bone. (auth)

3646 BLASTOMATOGENIC EFFECTS OF THOROTRAST IN AN EXPERIMENTALLY-PRODUCED CHRONIC RADIATION SICKNESS. I. A. Chalisov and A. N. Kishkovskii (Kirov Military Medical Academy, USSR). Med. Radiol., 8: No. 10, 65-71(Oct. 1963). (In Russian)

Research was done on 245 rabbits, of which 210 were subjected to a whole-body multiple low dose roentgen irradiation. Both in irradiated and control animals the object of the study was lymphatic system, involving the use of intravital lymphography. Thorotrast was introduced into soft tissues of the foot. In animals suffering from chronic radiation sickness, considerable changes developed at the site of the thoroplast injection. In 16 rabbits foot necrosis was recorded, in six others indurations appeared (thorotrast-granulomas), and in eight–malignant neoplasms (fibrosarcomas). No tumors were found in control animals. It was concluded that the whole-body external irradiation resulting in the development of chronic irradiation sickness tends to intensify the local biological thoroplast effect and, especially, its blastomatogenic action. (auth)

3647 NEW DEVELOPMENTS IN FLUOROSCOPY. Majic S. Potsaid (Harvard Univ., Boston). Med. Sci. (Philadelphia), 13: 49-60(Mar. 10, 1963).

Improvements concerned with the handling of radiographic images are reviewed. Much brighter fluoroscopic image may now be obtained at low levels of radiation without loss of good definition. This is desirable for: (1) reducing radiation exposure to the patients, examining physicians, and technicians; (2) allowing use of the more efficient central cone cells of the eye instead of the peripheral rod cells; enabling examinations to be performed in lighted or semilighted rooms. Recorded radiographic motion studies, either on film or videomagnetic tape, now play a major role as teaching aids in medical schools and in postgraduate training programs. Television methods offer unique opportunities for teaching patient dynamics at a low dosage x-ray exposure. Once a television signal is obtained it can be fed into a large number of monitors without additional radiation to the patient. Factors that have effects on image quality are considered. Contrast in the image is altered as the energy or penetrating power of the radiation is changed by generating the x rays at different kilovoltages. In fluoroscopy, image quality is affected by many technical considerations. Amplification and intensification techniques for enhancing the fluoroscopic image are discussed. It is possible now to obtain sufficient fluoroscopic light to take x-ray films from a few a second up to a hundred or more a second. The most widely used systems employ an electron image intensifier that can increase the brightness of the ordinary fluorescent screen 1000 times or more with currently available tubes rated at 3000 times the intensity of a dark-adaption fluoroscope. (BBB)

3648 PRODUCTION OF HYDROGEN ATOMS IN TEETH BY X-IRRADIATION. Terry Cole and Arnold H. Silver (Ford Motor Co., Dearborn, Mich.). Nature, 200: 700-1(Nov. 16, 1963).

Several observations of electron magnetic resonance in human teeth in vitro are reported. An initial search in the unirradiated material at room temperature disclosed no paramagnetic resonances in the region 3300–10200 gauss. Immediately following the 2.5 days after irradiation electron magnetic resonances spectra were observed at room temperature. The spectra exhibit three salient features: a broad line centered at g = 2.003 and approximately 20 gauss wide between the inflexion points; a Pake shape line the absorption curve maximum of which lies at g = 2.0004; and a weak doublet centered at g = 2.0029 ± 0.0003, corrected for second-order effects, and a splitting of 498 ± 2 gauss. Several conclusive arguments are made for the identification of a doublet in one spectrum as hydrogen atoms. (P.C.H.)

3649 A FAST-NEUTRON SOURCE FOR RADIOTHERAPY. D. K. Bewley (Hammersmith Hospital, London). Nature, 200: 701(Nov. 16, 1963).

Speculation is given on the value of 14 Mev neutrons for radiotherapy. It is argued that the grain factor of 14 Mev neutrons may be in the region of 1.5, which would be of therapeutic value. (P.C.H.)

3650 RADON OINTMENT IN SUPERFICIAL RADIATION INJURIES. C. C. Anderson. New Zealand Med. J., 58: 69-71(1959).

Satisfactory results of this therapeutic technique are described with reference to the case histories of 14 patients. (BBB)

3651 SOME PROBLEMS IN THE DEVELOPMENT OF THERAPY FOR CERVICAL CARCINOMA. S. Izuchi, K. Maeda, M. Yagi, J. Kubota, and A. Kiyonaga. Nippen Sanfujinka Zasshi, 14: 907-12(Aug. 1962). (In Japanese)

Prevention of radiation injuries in treatment of gynecologic cancer is discussed. (BBB)

3652 COMPLICATIONS RESULTING FROM RADIOTHERAPY OF UTERINE CERVICAL CARCINOMA AND THE RELATION OF THE PATIENTS' CONDITION BEFORE TREATMENT TO SURVIVAL TIME, ACCORDING TO THE MATERIAL OF THE INSTITUTE OF ONCOLOGY IN GLIWICE. Anna Wieczorkiewicz, Irena Hliniakowa, and Janina Vorbrodtowa (Inst. of Oncology,

Gliwice, Poland). Nowotwory, 12: 131-8(Apr.-June 1962). (In Polish)

Complications arising from irradiation and co- and pre-existing factors influencing prognosis were analyzed from the records of 3012 cases of cervical carcinoma. The 5-yr cure rates varied from 57% for stage I to 7% for stage IV carcinomas. It was found that the co-existing anemia, and in the later stages, elevated body temperature, were indicative of poor prognosis. Auricular fibrillation is a contraindication to irradiation. The early and late complications were discussed. Early complications occurred in 35.2% of the total of 3012 patients; in 10% of the cases the complications were severe, and 2.8% of the patients died because of complications of irradiation. Complications were not related to any particular method of treatment. (BBB)

3653 A ROENTGEN TUBE FOR PROTECTION OF THE GONADS. Istvan Altorjay (Medical Univ., Szeged). Orv. Hetilap, 103: 179-80(Jan. 28, 1962). (In Hungarian)

It is pointed out that since x-ray examinations are being used more frequently today for the detection of various diseases, radiation effects on the gonads can be considerable during the lifetime of a person. It is estimated that an adult woman's ovaries receive 1.3 mr in a chest x-ray, 440 in a barium series, 430 during an examination of the duodenum, 290 in pyelography, and 240 in a pelvic examination. Since many newborn infants who are suspected to have pelvic dislocations or underdeveloped pelvic joints may undergo frequent x-ray examinations during the course of treatment, it is necessary to adequately protect them against gonadal exposure. To facilitate this a Juras roentgen tube was adapted as follows: in the upper end of the tube a mirror was installed which reflected a light downward and was translucent to x rays. The lower end of the tube contained two pear-shaped lead shields which were adjustable by springs. With this source of light (a 12-v, 35-w bulb) the lead shields could be adjusted by the examining roentgenologist who could determine from the shadow if protection was adequate. The pointed end of the lead shield was turned down when boys were examined to protect the testes or turned up when girls were examined. Control dose measurements, which proved the shield's usefulness, were conducted with an autoheliophos roentgen apparatus with a focus of 90 cm and operated at 47 kv. Without the lead shield the upper abdominal skin received 50 mr, lower back skin 8 mr; with the shield upper abdominal skin 2–3 mr, and lower back skin 1–2 mr. The dose directly adjacent to the light-shaded area was 47 mr. (BBB)

3654 CLINICAL AND EXPERIMENTAL FINDINGS CONCERNING THE EFFECT OF LOW X-RAY DOSES ON MALIGNANT TUMORS. S. Pineles, St. Grigorescu, I. Popp, A. Rivenzon, and Anne Trancu (Institute of Oncology, Bucharest). Radiobiol. Radiotherap., 3: 491-8 (1962). (In French)

Since conventional radiation treatment of malignant tumors has harmful side-effects on healthy tissue, attempts were made to determine conditions under which cure might be made without affecting normal tissue. The experiments described here supplement previous results of Pineles et al. showing clinically that fractionating and spacing of doses led to inhibition of tumor growth without notable side effects. In the present experiments, groups of rats or mice were grafted with tumors (sarcoma 10B 9, Guerin T8, Ehrlich ascites) then x irradiated with varying doses, 0.25, 0.5, or 1 r (given daily) or 5, 10, 15, 25, or 50 r (given every 2 days) at the rate of 2 r/min. The daily (0.25- to 1-r) doses accelerated tumor growth in 15 of 16 groups. Doses of 5 and 10 r had no conclusive effect; doses of 15, 25, and 50 r inhibited tumor growth in all cases. Side-effects were considered insignificant: slight leukopenia following 25- and 50-r doses; slight lesions in spleen with 0.25- to 1-r doses. In addition, clinical observations were made in 50 cases of malignant skin tumors treated by highly fractionated doses: 15–30 r/day, to a total of 1000–2500 r given over periods up to 150 days. In 46% of these cases the tumors disappeared; 36% showed improvement, and 16% failed to improve. Epidermization was accompanied by diminution and sometimes disappearance of the tumor; depilation occurred consistently, but erythema only rarely. Some mechanism other than normal cytolysis was concluded to be involved in diminution of tumor mass. An indirect effect of radiation on the organism's defense mechanisms or connective tissue, it was concluded, predominates over the direct effect on the tumor of radiation applied in multiple small doses. (BBB)

3655 ADVANTAGEOUS COMBINATIONS OF THE OSGOOD IRRADIATION OF THE WHOLE BODY AND OTHER FORMS OF THE TREATMENT WITH IONIZED RAYS IN CHRONIC LEUKEMIA. G. Benkoe and T. Burger (Univ. of Pecs, Hungary). Radiobiol. Radiotherap., 4: 283-8(1963). (In German)

Results are reviewed for 67 patients with chronic leukemia treated with different methods of x irradiation. The advantages of combinations of whole-body and local irradiation in lymphoid leukemia are discussed. (C.H.)

3656 LOCAL AND REMOTE REACTION OF THE BONE MARROW UNDER THE INFLUENCE OF ROENTGEN RAYS. A. Morczek and K.-H. Klare (Medizinischen Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 4: 377-83 (1963). (In German)

Qualitative and quantitative examinations of the morphology of human bone marrow before and after therapeutic x irradiation were performed. The known radiation effects due to direct irradiation were confirmed and illustrated by examples. The propagation of certain cellular forms which are morphologically closely connected with blood monocytes was proved and their origin from the reticulum, which is relatively immune to rays, is discussed. The reactions of medullary organs remote to the site of irradiation proved more complicated than direct irradiation. Nevertheless, a type of reaction which appeared to be dominating and to which a compensatory function may be attributed was observed. (auth)

3657 PORTABLE STRONTIUM-90–BARIUM X-RAY SOURCE (ORINS). Akira Tsuya (Yokohama Municipal Univ. Hospital, Japan). Radioisotopes (Tokyo), 12: 101-6 (May 1963).

A small portable strontium-90–barium x-ray source is described. The differential spectrum of the x rays revealed a Bremsstrahlung peak at about 110–120 kev; the half-value-layer of aluminum was 6100 ~ 6200 mg/cm^2, corresponding to about 100 effective kev. Poor definition in clinical x-ray pictures is considered due to relative high penetrating power and large target size. (auth)

3658 TREATMENT OF BREAST CANCER WITH HIGH-ENERGY ELECTRONS PRODUCED BY 24-Mev BETATRON. Florence C. H. Chu, Lourdes Nisce, and John S. Laughlin (Memorial Hospital for Cancer and Allied Diseases, New York; James Ewing Hospital, New York; and Sloan-Kettering Inst. for Cancer Research, New York). Radiology, 81: 871-80(Nov. 1963).

From Jan. 1, 1955, to June 30, 1960, 222 patients with breast cancer were treated by high-energy electrons.

With the exclusion of one case of angiosarcoma and three cases of carcinoma of the male breast, there remained 218 carcinomas of the female breast as a basis for evaluation. Thirty-nine of the 50 (78 per cent) inoperable carcinomas treated showed favorable response for a mean duration of twelve months. One hundred of the 135 patients (74 per cent) treated for recurrent or metastatic disease responded favorably for a mean of eight months. Many patients in this group had received prior irradiation to the same areas. They tolerated the electron treatment well. The objective response of the tumors was comparable to those obtained from x-ray irradiation. Thirty-three patients received postoperative treatment. Systemic reaction was minimal, skin reaction was not excessive, and the incidence of radiation pneumonitis and fibrosis was relatively low (8 to 10 per cent). There was one case of multiple rib fractures resulting from overdosage to the ribs because of faulty alignment of the fields during treatment. Advantages of electron irradiation include easy manipulation, convenient adjustment of the depth of penetration of radiation, absence of increased bone dose, and satisfactory dose distribution in most cases. Disadvantages include some limitation in field (maximum 24 × 24 cm.), since faulty alignment of fields is possible during treatment when multiple adjacent portals are used, and the limitation in opposing field separation. The advantages, however, appear to us to outweigh the disadvantages. Electrons of the energies available to the authors have proved to be worthwhile, convenient, and effective in the treatment of tumors situated close to the body surface, such as breast cancer. (auth)

3659 THE USE OF TRACERS IN THE STUDY OF THE KINETICS OF METABOLIC PROCESSES. U. Salera and P. Magnanelli. Recenti Progr. Med., 29: 92-122 (July 1960). (In Italian)

Biologic applications of radioisotopes as tracers are reviewed. (BBB)

3660 RADIATION DOSE AND PROTECTION IN PEDIATRIC X-RAY DIAGNOSIS. M. A. Lassrich. Rev. Chilena Pediat., 33: 57-66(Feb.-Mar. 1962). (In Spanish)

Protection of children against exposure and dose reduction methods are discussed. (BBB)

3661 A CASE OF CERVICAL MYELITIS AFTER COBALT THERAPY (IRRADIATION FOR NEOPLASM OF THE NASOPHARYNGEAL CAVITY). A. Pech, R. Clement, J. Boudouresques, and R. Avierinos (Hôtel Dieu, Marseille). Rev. Oto-Neuro-Ophtalmol., 33: 78-83(Feb. 1961). (In French)

The case of a 40-yr-old woman with epidermoid cancer of the nasopharynx is cited, showing cervical lymph adenopathy and nasal obstruction before radiotherapy was begun. Co^{60} therapy was given over 107 days, to provide a total tumor dose of 7200 r and a dose of 7000 r to adjacent involved lymph nodes. After three months, complications of the treatment were noted, including hemiparesis, pain in the arms and legs, and generalized acroparesthesia. Facial and cranial nerves were unaffected. A month later the patient was unable to walk. Neurologic examination showed quadriparesis, especially on the right side, but no signs of cerebral damage or sensory impairment other than inability to recognize objects by feeling them. Radiologic examination of the cranium and spine, eye grounds examination, electroencephalography, carotid arteriography, and hematologic tests were all negative. Cervical myelitis as a result of cobalt therapy was the final diagnosis, and as treatment 40 mg/day of prednisone was given for six weeks. This improved the patient's condition progressively, and this improvement was maintained seven months later. The literature relating to similar paralytic injuries as side-effects of radiotherapy is reviewed with reference to 37 previously reported cases. For each of these cases the tumor site, radiation dose, and clinical symptoms are tabulated. (BBB)

3662 SURGICAL TECHNICS AND THEIR APPLICATIONS IN POSTOPERATIVE AND POSTIRRADIATION LESIONS OF THE URETER. Jose M. Gil-Vernet, Jr. Rev. Venezolana Urol., 13: 299-324(July-Dec. 1961). (In Spanish)

The repair of radiation-injured ureters by plastic surgery is described and illustrated. (BBB)

3663 THE DETERMINATION AND MEASUREMENT OF SURFACE DOSES IN ROTATION IRRADIATION. Iwao Azuma, Gunther Barth, and Felix Wachsmann (Universität, Giessen, Ger. and Universität, Erlangen-Nurenberg, Ger.). Strahlentherapie, 122: 161-5(Oct. 1963). (In German)

Correction factors for calculation of the effective width of the skin field are reported using phantom measurements. By use of these factors, actual surface doses can be determined from the geometrical skin field size and body circumference during rotational irradiation. (auth)

3664 SIEVE IRRADIATION IN TELECESIUM THERAPY. Helmut Kuttig and Hildegard Braeutigam (Universität, Heidelberg). Strahlentherapie, 122: 166-73(Oct. 1963). (In German)

Application of the grid-method in telecesium therapy is described, and there is a report on dose distribution with the aid of film dose measurement, using a perspex phantom. Dose proportion under the grid openings and under the cover plate are between those with grid-radiation using conventional x-ray and Co^{60} γ rays. The considerable surface dose by secondary electrons, which were contaminated from the grid, can be reduced considerably by a plexiglass filter of 2-mm thickness. Although the maximal dose is brought to the surface by this method, the surface dose is less than without filter. (auth)

3665 CENTERING THE DISEASE AREA FOR MOVING ROENTGEN IRRADIATION. Ljuben Minkow and Ilian Stratew. Strahlentherapie, 122: 179-82(Oct. 1963). (In German)

A method for localizing the focus in the diseased area during x-ray moving field irradiation of tumors is described using control planograms. Localization is done on the irradiation table in the position which the patient has during the irradiation. The pictures are taken with the therapeutic tube without additional diagnostic focus. (auth)

3666 OUR EXPERIENCES IN THE TREATMENT OF EYE-LID CANCERS. Milan Spoljar and Miodrag Konstantinovic (Univ. of Zagreb). Strahlentherapie, 122: 183-9(Oct. 1963). (In German)

Ionizing radiation treatment causes the same reaction in carcinomas of the eyelids as in skin carcinomas. The proximity of the eye represents an especially difficult situation, because it can be damaged by irradiation. One hundred six patients were examined; 84% with basal cell carcinomas and 14% with squamous cell carcinomas. The average age of the patients was 58 years. Radiotherapy was effective for 85% and 88%, respectively. (auth)

3667 CONCERNING OPTIMAL WAVELENGTHS, ABSORPTION, AND BIOLOGICAL EFFECTS. Gustav Peter. Strahlentherapie, 122: 190-7(Oct. 1963). (In German)

The calculation of the x ray energy, which is absorbed in tissues, by subtracting a percentage depth dose from the

surface dose produces erroneous results and concepts which may cause the therapist to estimate the tolerance of the skin and of deeper-seated tissues too high and to give doses which eventually may be dangerous. (auth)

3668 THE BRAGG PEAK OF A PROTON BEAM IN INTRACRANIAL THERAPY OF TUMORS. Raymond N. Kjellberg, William H. Sweet, William M. Preston, and Andreas M. Koehler (Massachusetts General Hospital, Boston). Trans. Am. Neurol. Assoc., 87: 216-18(1962).

Results are reported on four patients with tumors treated by intracranial irradiation with the Bragg peak of a proton beam from the 160-Mev Harvard cyclotron, as well as radiobiological investigations in 100 monkeys demonstrating experimentally the feasibility of the method. Protons, emerging from the portal of the cyclotron at great speeds, can be directed in nearly straight lines so that at the end of their range (the Bragg peak) they stop at the brain target and liberate greater amounts of ionizing radiation than elsewhere along their path. Combining the Bragg peak with multiple portals of entry permits large doses of radiation, up to 20,000 rad, to be delivered to an intracranial target while surrounding zones receive a significantly lower dose. Use of the Bragg peak has advantages over the full penetration techniques. The fact that the beam penetrates only to target, combined with the greater ionizing energy yield of the Bragg peak, reduces by $\sim 1/3 - 1/6$ the dose to nontarget portions of the brain produced by a full-penetration method. Furthermore, a variety of portals can be selected because no emerging beam threatens radiosensitive structures such as the eyes, gonads, or blood-forming tissues. Cebus monkeys were used to assess such factors as the total dose and dose rate. The technique permits focal cerebral destructions through skin, bone, and brain without making any opening along the path of the beam. To ensure that the brain target is superimposed on the Bragg peak, a precise stereotactic system is required. An instrument was designed that provides bony fixation to the skull by tiny drill rods that enter the outer table of the skull to maintain the head position most firmly. The brain target is identified by bone landmarks or encephalography. The instrument is adjusted to bring the centers of rotation of the instrument precisely on the brain target, and the Bragg peak is precisely superimposed on the center of instrument rotation. Thus, the patient's head is rotated around the two axes, permitting a large number of beam path portals while the brain target remains on the Bragg peak. A telescoping water absorber permits the proper penetration into the brain after a small correction is made to compensate for the difference in absorption of brain and bone from water. The technique makes it possible to irradiate malignant brain tumors (gliomas), tumors of the pituitary region, and vascular malformations. Hypophysectomy can be done with reduced risk to surrounding structures in an awake, comfortable patient. Successful results are reported in three patients with intracranial malignancies and one who underwent palliative hypophysectomy for breast cancer. Its use in alleviation of Parkinson's disease is planned. (BBB)

3669 THE RESPONSE OF DISSEMINATED RETICULUM CELL SARCOMA TO THE INTRAVENOUS INJECTION OF COLLOIDAL RADIOACTIVE GOLD. Philip Rubin (Univ. of Rochester, N. Y.) and Seymour H. Levitt. 21p. (CONF-164-7)

From Society of Nuclear Medicine 10th Annual Meeting, Montreal, June 1963.

Case histories of two patients treated with colloidal radiogold for diffuse reticulum cell sarcoma are presented. Further analysis of the method is suggested by the unusually long survival time of one of the patients. It was concluded that, although external radiotherapy remains the treatment of choice in localized reticulum cell sarcoma, intravenous colloidal radiogold may be a useful agent in lymphosarcomas with diffuse minute neoplastic liver and spleen involvements. Intravenous colloidal radiogold can produce bone marrow depression and thrombocytopenia which can lead to death. This factor tends to argue against therapeutic use of the agent. It is suggested that no more than 50 mC Au^{198} intravenously should be used for treatment of this disease. (H.M.G.)

3670 PROTECTIVE NOZZLE FOR X-RAY MACHINE. Charles Okun and Jeannette Okun. U. S. Patent 3,112,402. Nov. 26, 1963. Priority date Dec. 19, 1959, Canada.

A protective device for attachment to x-ray equipment for confining the random emanation of radiation from the x-ray machine is described. The nozzle consists of an inner tube of a material substantially opaque to x rays with an attachment to secure it to an x-ray machine, a second tube surrounding and secured to the first tube, a plurality of elongated slat members of a material substantially opaque to x rays longitudinally aligned with and slidable relative to the longitudinal axis of the tubes and arranged about the outer surface of the second tube with the longitudinal edges of each slat member contacting the adjacent slats, and a third tube surrounding the first and second tubes and slat members. The slats can extend to conform to the surface irregularities of an object being x rayed. (M.C.G.)

CHEMISTRY

General

3671 (BNL-799(p.26-54)) CHEMISTRY AND CHEMICAL ENGINEERING DIVISION. O. E. Dwyer and R. H. Wiswall (Brookhaven National Lab., Upton, N. Y.).

High-temperature emf measurements were used for the determination of the free energy of formation of nickel fluoride, NiF_2, at 600°C, and of differential free energies of mixing in the fused-salt system $CaCl_2$–NaCl at 820°C. The irradiation of xenon-fluorine mixtures was found to produce mixtures of XeF_2 and XeF_4. The radiolysis of two more fluorocarbons, the analogues of cyclohexane and bicyclohexyl, was investigated. Absorption spectra were obtained on the systems Zn–$ZnCl_2$ and Sn–$SnCl_2$ in the liquid state, on solid $SnCl_2$, and on $CdCl_2$ above and below the melting point. It was found that in the presence of hydrogen alone graphite can be converted to pyrolytic graphite at 1900°C. The variation of surface area with particle size was studied for nuclear graphites by using the Kr^{85} traced Kr surface apparatus. It was found that stainless steel is severely attacked by reaction with oxygen at 700°C in a fluidized bed of alumina containing ~1% by weight of certain metal fluorides. Zr dissolves readily in NOF·3.1HF at room temperature. Information was obtained on the reaction of Al with NOF·3.1HF. The effectiveness of solvents containing NOF·3.1HF in the dissolution of graphite-matrix fuel containing UC_2 particles coated with pyrolytic carbon was studied. The addition of NO_2 and, separately, of UF_6 did not result in a solvent of useful properties. The mixture containing UF_6 disintegrated the graphite but did not affect the coated particles. A mixture of NO_2 and HF remains the best reagent for such fuels. Evidence was obtained that NOF and HF do not form a compound with the formula NOF·6HF. It forms when water is added to NOF·3.1HF. A study of the corrosion of metals in Nitrofluor Process liquids was begun. The kinetics of the attack of NO_2–HF mixtures on Monel indicate the formation of protective films under certain circumstances of temperature and NO_2 concentrations but not under all conditions. Iodine is released from irradiated metallic U at 1200°C into He in some combined form, probably as a uranium iodide. Iodine is released from U into steam primarily in the I^- state; <8% is released as I^0, IO_3^-, and IO_4^-. A new compound UTe_3, was prepared by reacting U and Te vapor at 600°C. A number of satisfactory runs was made with the phosphate glass pilot plant in which steady state conditions of operation were achieved. An extended run was made with the Rotary Calciner Pilot Plant. Results were obtained on three more test elements in the measurement of heat transfer coefficients for turbulent, in-line flow of NaK through unbaffled rod bundles. A slight amount of bowing of the rods apparently has great effects on the heat transfer characteristics of rod bundles. A wholly theoretical equation was developed for predicting heat transfer rates to liquid metals flowing crosswise through rod bundles. (auth)

3672 (BNL-799(p.64-73)) HOT LABORATORY DIVISION. L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.).

Search for triton-induced reactions on high Z targets has failed to provide evidence for (t,p) or (t,n) reactions on Ba^{138}. The chemistry of Se is being studied, preparatory to developing an As^{72} generator. Formation and hydrolysis constants of $SeCN^-$ were measured, and work is in progress on the extraction chemistry and chromatographic behavior of the complex between Se and o-phenylenediamine. The $Cr^{50}(\alpha,2n)Fe^{52}$ reaction will be used with enriched Cr^{50} to prepare Fe^{52} by using a chemical separation process. The cause of sporadic poor yields from Sr^{87m} generators is under investigation. A method of preparing the target used for producing the parent Y^{87} was developed. The entire process for producing Te^{132}–I^{132} and Mo^{99}–Tc^{99m} is being re-examined with a view to eliminating trace impurities. The study will also determine conditions for minimizing the I^{131}/I^{132} ratio and for stabilizing the milking yields. Efforts to produce ultra-high specific activity Mg^{28} by recoil techniques continue. The study of the synergistic extraction of Am by TTA and TnOA continues. In the presence of 2 M LiCl, no hydrolysis occurs at $[H^+] \geq 2 \times 10^{-4}$ M. In the absence of TTA, dilute TnOA in benzene extracts no Am from 2 M LiCl at 0.01 M $\geq [H^+] \geq 2 \times 10^{-4}$ M. A method was devised for correcting for pH changes during equilibration of phases, and experiments are in progress to measure the enhancement of TTA extraction by TnOA. Fluorescence in actinide chelates is being investigated. A reported color reaction between Nd and 3,3′-diaminobenzidine was investigated and found not to occur. Color reactions between KSeCN and Fe^{3+}, Ni^{2+}, and Co^{2+} were found. In the hydrolysis of Ce^{+3} in the region 1 M > $[Ce^{+3}]$ > 0.01 M one predominant species was found: $Ce_3(OH)_5^{+4}$. Incremental polarographic studies of U(VI) in EDTA point to disproportionation of the primary electrode product, U(V), at an appreciable rate. Activation analysis is being made more specific in certain cases by counting characteristic x rays following internal conversion. This technique was used successfully in the analysis of trace amounts of Cd and Gd deposited on an Al alloy plate, and it shows promise for the analysis of traces of Co in the residue from distilled Hg. Investigation of the possibility of using unique gamma-ray spectra resulting from radiative capture as a basis for a new technique in radioactivation analysis shows that the state of the art is such that the method can not be applied generally but may be of interest for a special case in which the matrix has a low (n,γ) cross section and the nuclide sought has a high (n,γ) cross section. Rb and Y are being determined by an x-ray fluorescence method under development. (auth)

Analytical Procedures

Refer also to abstract 4903.

3673 (EUR-307.e) ABSOLUTE DETERMINATION OF THE U-235/U-238 RATIO WITH AN OPTICAL INTERFEROMETER (HYPEAC). C. Berthelot and K. F. Lauer (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). 1963. 23p.

An optical method for the absolute determination of the isotope ratio of U^{235}/U^{238} is described. The recording of the homologous lines of uranium is effected by using a photoelectric Fabry-Perot interferometer (Hypeac). A series of samples of uranium oxides containing from 3 to 93% of U^{235} (NBS standards) has been analyzed and the results agree to within ±0.70% with those given by the National Bureau of Standards. The relative precision of the method is of the same order, i.e., about ±1% at the 99% confidence level. (auth)

3674 (MCW-1468) INFRARED ABSORPTION ANALYSIS OF URANYL FLUORIDE IN URANIUM(IV) FLUORIDE (QUANTITATIVE DETERMINATION IN THE SOLID PHASE). H. E. Peña (Mallinckrodt Chemical Works, Uranium Div., Weldon Spring, Mo.). Dec. 2, 1963. Contract W-14-108-eng-8. 14p.

A method is described for the direct infrared absorption determination of uranyl fluoride in uranium(IV) fluoride. The integrated absorption intensity of the uranyl ion in uranium(IV) fluoride was measured from the recorded spectra. The potassium bromide sample preparation technique was used. A comparison was made between the values obtained by this method and those obtained by the exhaustive extraction of uranyl fluoride. The most favorable condition for the total extraction of uranyl fluoride from uranium(IV) fluoride is by the use of absolute methanol as a solvent. The infrared method shows that the total uranium(VI) content is production-grade uranium(IV) fluoride exists in part as an alcohol-soluble uranyl ion and in part as an alcohol-insoluble uranium(VI) compound. (auth)

3675 (NAA-SR-Memo-8943) COMPARISON OF MICROSTRUCTURE AND CHEMICAL CARBON CONTENT FOR HYPOSTOICHIOMETRIC URANIUM MONOCARBIDE. W. R. Kerr (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 9, 1963. Contract [AT(11-1)-Gen-8]. 23p.

Determination of the carbon content of hypostoichiometric UC by estimation of the amount of free uranium visible in the microstructure was used for quality control of the ESADA Pilot Run. The metallographic analyses can be related to chemical carbon content if impurities, kinetics, and accuracy of standard are considered. Nitrogen and oxygen replace carbon in UC and raise the "carbon content" as determined metallographically. Rapid cooling rates attained in casting raise the apparent carbon content by quenching excess uranium in metastable solid solution or as unresolvable precipitates. Photomicrographs used as standards for comparison must truly represent the carbon contents for which they are designated. (auth)

3676 (NP-13320) ANALYSE DE RESULTATS DE LA COMPARAISON INTERNATIONALE DE ^{35}S. (Analysis of Results of the International Comparison of S^{35}). J. C. Roy (Bureau International des Poids et Mesures, Sèvres, France). June 1962. 26p.

Fifteen laboratories participated in the international comparison of S^{35} in June 1962. Twenty results are discussed since the Bureau Central de Mesures Nucleaires, Geel, Belgium, used four methods of measurement and the Institut für Angewandte Radioactivity, Leipzig, used three methods of measurement. The methods used were the tracer method using a 4 π counter, the 4 π counter method, the liquid scintillating method, internal counting of S in the gaseous state, theoretical estimation of the self-absorption using a tracer, and a tracer method using a scintillating liquid to measure the beta activity. The results are given and analyzed in detail. (J.S.R.)

3677 (NSEC-85) DEVELOPMENT OF DOUBLE ISOTOPE DERIVATIVE DILUTION ANALYSES FOR SELECTED FOOD ADDITIVES. Final Report. R. L. Bogner, N. S. Domek, S. Eleftheriou, and J. J. Ross, Jr. (Nuclear Science and Engineering Corp., Pittsburgh). May 15, 1963. Contract AT(30-1)-2715. 105p.

Results of initial investigations designed to demonstrate the feasibility of double isotope derivative dilution analyses for selected chemical residues in foods are presented. Four compounds were selected as representatives of commonly employed pesticides of different chemical structures that would necessitate the exploration of a variety of isotope derivative procedures. In this way, it was anticipated that the feasibility of radioisotope procedures could be demonstrated and further investigations of the techniques could be stimulated. The four pesticides studied were DDT, dieldrin, systox, and diazinon. A double isotope derivative dilution analysis for DDT was devised based on the tetranitration of DDT and added C^{14}–DDT, subsequent formation of the dianilide derivative with H^3–aniline, purification of the double-labeled derivative by paper chromatography, and simultaneous counting of the H^3- and C^{14}- content of the derivative in a liquid scintillation spectrometer. One- to 10-μg quantities of DDT were determined by using C^{14}–DDT and H^3–aniline of specific activities which are readily available and easily prepared. Simultaneous determination of DDE is discussed and the expected advantages of the isotope dilution procedure are reviewed. Dieldrin was shown to be amenable to analysis by a double isotope derivative dilution procedure which involved derivatization of dieldrin and C^{14}–dieldrin with H^3–acetic anhydride to form a double-labeled derivative and purification by multiple recrystallizations with carrier non-labeled dieldrin derivative. A potential isotope derivative procedure for systox was suggested by the demonstration that hydrolytic cleavage of the thiono and thiol isomers yielded β-hydroxydiethyl sulfide and β-mercaptodiethyl sulfide, respectively, which could be derivatized with dinitrobenzoyl chloride, a reagent that can readily be tritium-labeled. (auth)

3678 (NYO-10517(p.135-41)) COMPARISON OF Rb–Sr BY X-RAY SPECTROGRAPHIC AND MASS SPECTROMETRIC METHODS. H. W. Fairbairn (Massachusetts Inst. of Tech., Cambridge).

The Rb/Sr ratio in nineteen whole-rock samples were determined both by x-ray spectrometry and by isotope dilution analysis. The results are presented and compared. (D.C.W.)

3679 (PG-Report-510) ANALYTICAL METHOD FOR THE DETERMINATION OF URANIUM IN BOVINE FAECES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 10p.

A procedure is described for the determination of U in bovine feces. The dried sample is ignited in a muffle furnace and the residue digested with hydrofluoric acid. After evaporation, the residue is dissolved in nitric acid and the U is separated by ether extraction and assessed fluorimetrically using an internal standard. This method has been used for samples containing up to 15 μg U/g of dried sample. This range can be extended by using suitable dilutions. (C.H.)

3680 (TID-7015(Suppl.5)) ORNL MASTER ANALYTICAL MANUAL. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 800p.

A total of 33 new methods are presented which are to be added to the ORNL Master Analytical Manual. These include 6 ionic methods, 1 radiochemical method, 22 nuclear analyses methods, and 3 general process methods. (D.L.C.)

3681 ANALYSIS WITH DIRECT-READING SPECTROMETER OF NUCLEAR GRAPHITE. M. Roca Adell, E. Becerro Ruiz, and F. Alvarez González (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B., 59: 335-44(May 1963). (In Spanish)

A description is given about the application of a direct-reading spectrometer, the Quantometer, to the determination of boron, calcium, iron, titanium, and vanadium in nuclear-grade graphite. For boron the powdered sample is

mixed with 1% cupric fluoride and excited in a 10-amp d-c arc and graphite electrodes with a crater 7-mm wide and 10-mm deep. For the other elements a smaller crater was used and dilution with a number of matrices was investigated; the best results were achieved by employing 25% cupric fluoride. The sensitivity limit for boron is 0.15 ppm. (auth)

3682 ANALYSIS WITH DIRECT-READING SPECTROMETER OF MAGNESIUM ALLOYS. M. Roca Adell (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 345-50(May 1963). (In Spanish)

A Quantometer was applied to the determination of aluminum, beryllium, calcium, iron, silicon, and zinc in magnesium alloys, "Magnox", after the conversion of the samples to the oxide. For the aluminum, whose concentration is relatively high, the conducting-briquet technique with an interrupted discharge was employed, using the magnesium as the internal standard. For the other elements a total burning method with d-c arc was employed, using also the magnesium as the internal standard. The standard deviations of determinations ranged from ±2.2% to ±6.6%. (auth)

3683 SPECTROPHOTOMETRIC DETERMINATION OF MICROAMOUNTS OF THORIUM WITH THORIN IN ORGANIC SOLUTIONS, AFTER EXTRACTION WITH TRIBUTYL PHOSPHATE-METHYLISOBUTYL ACETONE. J. Gómez-Pantoja, J. Vera Palomino, and J. C. Petrement (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 351-64(May 1963). (In Spanish)

Some modifications in the extraction process and in the measurement conditions for the thorium determination method described by D. A. Everest and J. V. Martin are introduced and some other operations such as the thorium re-extraction from the organic to the aqueous phase are suppressed. Various TBP concentration levels in MIC (methylisobutylacetone) and saline agent in the aqueous phase were considered. The plotting of the experimental results led to a curve family given by the following equation: $\log E = 2 - (K_1/K_2 - K_3)\, K_4(c/2 - 1)$, where E is the percent of thorium extracted, n the concentration of saline agent in the aqueous phase, c the TBP concentration in MIC, and all others are constants. With this equation equal curves in the n, c plane were obtained, from which the optimum working conditions can be deduced. Absorption spectra of the thorium-thorin complex in different organic solvents were obtained. The influence and the elimination of numerous interferences and systematic and variable errors of the method were studied. Because of the modifications introduced, thorium concentrations in the range 1 to 20 μg/ml can be determined, instead of 400 to 800 μg/ml in the original method, and the reproducibility of the results, in spite of working at a lower range of concentrations, is increased. (auth)

3684 SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTH ELEMENTS. II. ELIMINATION OF CORRECTION FACTORS. J. Vera Palomino, F. de la Cruz Castillo, and R. Fernández Cellini (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 365-78(May 1963). (In Spanish)

The application of correction factors in the spectrophotometric determination of rare earth elements is not always correct and sometimes can produce great errors. A way of removing these errors by replacing the concentration factors corresponding to λ_{max} by those derived by taking into account the absorbance difference between λ_{max} and λ_e where λ_e is a wavelength value properly chosen in every case is proposed. The concentration factors were calculated and the method was applied to the determination of elements of the cerium and yttrium groups in synthetics. The results were compared with those obtained from the correction factors, as well as in rare earth concentrates obtained by separation by ionic interchange. (auth)

3685 MULTICOMPONENT RADIOMETRIC ANALYSIS OF ROCK SAMPLES USING THE LSU-5K ("LAURA")-TYPE SCINTILLATION INSTRUMENT. A. L. Yakubovich, E. I. Zaĭtsev, and V. V. Anosov. At. Energ. (USSR), 15: 224-30(Sept. 1963). (In Russian)

The individual determination of U, Ra, Th, and K in mineral deposits containing radioactive elements is of considerable importance in prospecting. For this reason, a four-component analysis of slightly radioactive specimens was developed including the separate determination of these elements. The presence of β- and γ-emitting K^{40} complicates the analysis of U, Ra, and Th; therefore the radioactivity parameters must be determined with great accuracy. For U, γ measurements in the 95- to 110-kev range were used; while for Ra and Th, the best separation coefficients were obtained by differential γ measurements at 240 and 350 kev. The 240-kev Pb^{212} γ line was found useful in the absence of large amounts of Ra. The photopeaks of 340 and 350 kev of Pb^{214} made it possible to measure the Ra, as the count rate of Th was much lower. The K could be determined by differential γ measurements of the 1.45-Mev photopeak of K^{40} or by β measurements. The analysis is carried out by solving 4 equations. The instrument used for the measurements, designated as LSU-5K (Laura), allowed the simultaneous determination of the 4 parameters. It consisted of a combined β-γ counter in a 70-mmm thick Pb shield and the required amplifying and recording system. A scintillation counter provided with NaI(Tl) crystal was used for γ measurements; stilbene scintillators served for β counting. Placement of the instruments over each other made it possible to carry out the measurements simultaneously. (TTT)

3686 SOME OF THE PROBLEMS INVOLVED IN THE THEORY OF THE LABORATORY PHOTONEUTRON METHOD USED FOR THE DETERMINATION OF BERYLLIUM. V. N. Smirnov and D. V. Tokareva. At. Energ. (USSR), 15: 334-5(Oct. 1963). (In Russian)

The method based on the (γ,n) reaction is widely used for determining Be in ores, concentrates, and metallurgical products. Under laboratory conditions, linear sources with coaxially arranged samples were found desirable for photoneutron analysis. In further improvement of method, an analytical expression was derived, allowing the number of neutrons produced in the (γ,n) reaction to be calculated as a function of the dimensions of the radiation source, taking into account their relative positions under conditions of coaxial geometry. In order to simplify the expression, it was assumed that the centers of the source and of the specimen are at the same level and that a point source is used. The equation was then numerically integrated by means of a computer and the reaction yield data, obtained with and without considering the absorption of γ rays in the specimen, were compared. The divergence of these 2 sets of data, ranging from 3 to 5%, was found to depend on the dimensions of the powder sample. Increasing the ratio of the height of the specimen to the length of the source resulted in a decrease of the divergence of the neutron yields from linear and point sources; at a ratio of 2 : 1, these results coincided. This indicated that use of the simplified formula is justified. (TTT)

3687 MICROCALORIMETRIC QUANTITATIVE DETERMINATION OF A MIXTURE OF PLUTONIUM-239, PLUTONIUM-240, AND EVENTUALLY, PLUTONIUM-241. Pierre Boivinet, Édouard Calvet, and Yves Ozias (C.N.R.S., Marseille). Bull. Soc. Chim. France, No. 8-9, 1742-5 (Aug.-Sept. 1963). (In French)

Some indications were given previously on the quantitative analysis of a mixture of Pu^{239} and Pu^{240} (Compt. rend., 254: 2964(1962)), and this method is completed in the present article. The principle of the method is given, and its precision is determined. The possible presence of Pu^{241} in the mixture makes this method imprecise. (J.S.R.)

3688 SPECTROPHOTOMETRIC DETERMINATION OF YTTRIUM OR LANTHANUM WITH METHYLTHYMOL BLUE. Hiroko Okada, Keiji Kaneko, et al. Bunseki Kagaku, 12: 822-6(Sept. 1963). (In Japanese)

Yttrium or lanthanum forms a stable, blue complex with methylthymol blue (MTB) at about pH 6 or above, which is supposed to have a one to one composition. At pH 6.4 MTB has an absorption maximum at about 440 mμ and its complex has a maximum at 610 mμ. Beer's law is obeyed over a range of 0 to 120 mμ of yttrium or lanthanum in 25 ml, and the molar extinction coefficient of the complex at 610 mμ is 2.60×10^4 for yttrium or 2.54×10^4 for lanthanum. Some heavy metal ions and large amounts of citrate, fluoride, phosphate, and tartrate ions decrease the absorbance considerably. (auth)

3689 MICRO-COULOMETRY OF COBALT USING COBALT-60. Mutsuaki Shinagawa, Hiroyuki Nezu, et al. (Osaka Univ.). Bunseki Kagaku, 12: 826-40(Sept. 1963). (In Japanese)

Coulometry was examined with several kinds of microelectrodes. A solution (50 ml) containing 5×10^{-3} F $Hg(NO_3)_2$ – 0.1F HNO_3 and 103 μC Co^{60} was the best among the solutions examined. Electrolysis was performed at the controlled potential of –1.50 v. To determine the amounts of cobalt electroreduced to the metallic state, γ rays from Co^{60} were utilized and were measured with a scintillation counter. From the results, it was found that the weight of cobalt deposited or the quantity of electricity passing through the electrode could be determined with a sensitivity of 2.87×10^{-8} g Co or 0.94×10^{-4} coulombs. (auth)

3690 DETERMINATION OF URANIUM(VI) IN UO_2 BY THE CONSTANT CURRENT COULOMETRY. Tsugio Takeuchi (Nagoya Univ., Japan) and Takayoshi Yoshimori, et al. Bunseki Kagaku, 12: 840-4(Sept. 1963). (In Japanese)

An accurate and simple method is described for the determination of U(VI) in uranium dioxide. The method is based on constant current coulometry using the titanium sulfate electrolyte proposed by Kennedy and Lingane. The sample (0.1 to 0.5 g) was dissolved readily in a mixture of 2N sulfuric acid and 1 to 2 drops of hydrofluoric acid, which was preferable to strong phosphoric acid. An aliquot of the solution was added to 35 to 40 ml of the electrolyte consisting of 7 to 8 M sulfuric acid, 0.6 to 0.8 M titanium sulfate, 10 mg of ferrous ion, 50 to 100 mg of uranium(IV) ion, and a few drops of hydrofluoric acid. Uranium(VI) was determined coulometrically using a sensitive amperometric end point procedure. Satisfactory results were obtained for 13 to 1240 μg of uranium(VI) when the indicator circuit potential was chosen at 0.14 to 0.16 v vs S.C.E. Results of stoichiometric analysis of uranium oxides (UO_2 and U_3O_8) are tabulated. (auth)

3691 SEPARATION AND DETERMINATION OF NIOBIUM AND TANTALUM. Juch'in Yu. Hua Hsueh Tung Pao, No. 6, 343-8; 357(1962).

A review on the determination and separation of Nb and Ta is presented. 57 references are given. (TCO)

3692 POLAROGRAPHY OF ZIRCONIUM AND HAFNIUM IN ACETONITRILE. J. W. Olver and J. W. Ross, Jr. (Univ. of Massachusetts, Amherst and Massachusetts Inst. of Tech., Cambridge). J. Inorg. Nucl. Chem., 25: 1515-19(Dec. 1963). (TID-19402)

Data on the polarographic behavior of zirconium and hafnium tetrachlorides in acetonitrile and in electrolytes of tetra alkylammonium perchlorate and halide are presented. The stepwise reduction of the metal ions to M(III), M(II), and M(O) is proposed and supported by the polarographic data. (auth)

3693 ANALYTICAL APPLICATIONS OF BETA-RAYS BACKSCATTERING. III. IMPROVEMENT OF THE SENSITIVITY BY THE PULSE HEIGHT ANALYZING METHOD. Shigemasa Enomoto, Tomihiko Furuta, et al. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 12: 263-72(May 1963). (In Japanese)

The effects of the observed angle and the atomic number of a specimen on the backscattered β-ray-intensity and energy spectrum were studied using P^{32} and $Sr^{90}-Y^{90}$ source and an anthracene scintillation counter followed by multichannel or single channel pulse height analyzers. The pulse height response and energy resolution power of the counter were previously determined by utilizing a β-ray spectrometer. Analytical work performed included the determination of the components of binary alloys, such as Cu–Sn and Sn–Pb, and a powder mixture of TiC–WC, and the concentration of $AgNO_3$, $CdCl_2$, KI, and $BaCl_2$ in aqueous solutions. The sensitivity of the measurements increased with the discriminating energy of backscattered β rays, and was similar to the value obtained by the filter method. (auth)

3694 SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN BERYLLIUM OXIDE. Kiyoshi Morita (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 12: 296-302 (June 1963). (In Japanese)

A method is described for the quantitative spectrographic determination of B, Fe, Al, Mg, Ni, Mn, Cr, Ca, Cu, Pb, and Si in beryllium oxide. The procedure involves the carrier distillation technique, the addition of graphite powder and barium hydroxide or gallium oxide to the beryllium oxide, and the excitation of this mixture in an a-c carbon arc. This method is applicable to samples with an accuracy of about 4 to 10 percent in error except for B and Pb. (auth)

3695 SPECTROPHOTOMETRIC DETERMINATION OF BERYLLIUM USING BERYLLON II. Katsuko Kunita and Shozo Shibata (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 12: 344-7(July 1963). (In Japanese)

A spectrophotometric determination of beryllium using beryllon II was studied. It was recognized that beryllium formed a blue water-soluble chelate compound with beryllon II under a basic condition and had a maximum absorption at 620 mμ. Absorbance followed Beer's law at the range of 0.02 to 0.6 ppm of beryllium and the molecular absorption coefficient was 11000. The amount of beryllium in aluminum was determined. (auth)

3696 METHODOLOGY AND INSTRUMENTATION FOR MEASURING RADIONUCLIDES IN FOODS. B. Branson, F. Burmann, and B. Kahn (Robert A. Taft Sanitary Engineering Center, Cincinnati). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 95-107(1963).

The variety of instruments and methods required for identifying and measuring the whole range of radionuclides that may be encountered are described. Fortunately, surveillance and experimental studies are usually limited to a single radionuclide or a small group, reducing the number of techniques that must be applied. Knowledge of the probable radioactive composition of the sample is vital, both for limiting required analyses and for selecting techniques that will minimize the influence of contaminating radionuclides. As an example, I^{131} fallout is in milk only within approximately two months after nuclear tests, and can vary in this time, hence I^{131} analysis by gamma spectroscopy is performed frequently by the Public Health Service. Only $Ba^{140}-La^{140}$, Cs^{137} and K^{40} interfere in these measurements and must be considered. During the same period, Sr^{89} and Sr^{90} vary gradually and are sampled less frequently, and in their radiochemical analysis only the above-mentioned fission products need be considered. Years after nuclear testing, only K^{40}, Cs^{137}, and Sr^{90} remain in milk for measurement. (auth)

3697 MEASUREMENT OF THE TRITIUM CONCENTRATION IN NATURAL WATERS. Yasushi Nishiwaki (Tokyo Inst. of Tech.) and Hiroshi Kawai. Shitsuryo Bunseki, 10: No. 21, 83-90(Oct. 1962). (In Japanese)

A method for monitoring tritium in natural waters is described. The water sample to be assayed is electrolyzed from six liters to a final volume of 5 ml or less in order to enrich the tritium. The radioactivity is measured with a liquid scintillation counter. The degree of tritium enrichment is estimated from the degree of deuterium enrichment, taking into consideration the relative separation factors of tritium and deuterium in electrolysis. The tritium in rain and tap water in Osaka City in 1957, and that in the water sampled at the Tamagawa River in Tokyo were assayed by this method, and were found to be in the order of 10^{-17} to 10^{-16} as expressed in the atom ratio of tritium to protium (T/H). It is found that at least 1000 fold enrichment of tritium is needed for measuring the tritium content in natural waters at the present level with the liquid scintillation counter. (auth)

3698 MICRO-ANALYSIS OF LITHIUM BY ISOTOPE DILUTION METHOD. I. STUDIES ON STANDARD SOLUTIONS. Setsuo Taniguchi, Izumi Shionoya, et al. (Osaka Univ.). Shitsuryo Bunseki, 10: No. 21, 108-12(Oct. 1962).

The relative errors in the micro-analysis of lithium of known quantities under condition of different error factors were examined. Lithium of 10^{-6} to 10^{-7} g order was determined with satisfactory accuracy. For the determination of lithium in 10^{-7} to 10^{-8} g order, the isotopic contamination exerts considerable influence on the relative error. (auth)

3699 THE QUANTITATIVE SPECTROGRAPHIC ANALYSIS OF $(Hf-Zr)O_2$ BY MEANS OF THE TAPE METHOD. W. J. Naudé and P. B. Zeeman (Univ. of Stellenbosch, South Africa). Spectrochim. Acta, 19: 2075-84 (Dec. 1963).

A spectrographic method for the determination of hafnium in zirconium in the concentration range of approximately 2% hafnium in zirconium to 99% hafnium in zirconium is described. Analytical conditions are such that the whole concentration range can be covered with a single exposure. The variable interval standard method was used. The advantages of the tape method, combined with the similarity of the chemical and physical behavior of hafnium and zirconium and the employment of analytical line pairs with similar excitation characteristics, provided an ideal system for obtaining reproducible spectrographic results. The coefficient of variation for the method varied between 1 and 1.3%. (auth)

3700 TWO-STEP MAGNETIC MASS SPECTROMETER FOR ANALYSIS OF SMALL AMOUNT OF IMPURITIES. V. I. Karataev (Ioffe Inst. of Physics and Tech., Leningrad). Vestn. Akad. Nauk SSSR, 33: No. 10, 65-6(Oct. 1963). (In Russian)

A compact two-step, single magnet, mass spectrometer with beam deflection in a homogeneous magnetic field is described. Each step of beam deflection through 180° produces ideal 360° focusing. Tests of the spectrometer showed 10^{-5}% sensitivity to K^{40} with a gas pressure of 10^{-5} to 10^{-6} mm Hg. Starting time is one hour; analysis time is 15 to 20 min. (R.V.J.)

3701 DETERMINATION OF SODIUM IN METALLIC TUNGSTEN BY A RADIOACTIVATION METHOD. V. I. Spitsyn, M. P. Glazunov, P. N. Kodochigov, and V. P. Ionov (Inst. of Physical Chemistry, Moscow). Zh. Analit. Khim., 18: 1272-3(Oct. 1963). (In Russian)

A radioactivation analysis of tungsten samples was carried out. The samples were irradiated during 20 hr with a thermal neutron flux of 8.7×10^{12} neutron/cm^2 × sec. The content of sodium in tungsten, which was found to be $(1.7 \pm 0.25) \times 10^{-3}$%, was determined by means of filtration of a comparatively soft γ radiation of tungsten. It was shown that under certain conditions small amounts of potassium and aluminium in tungsten can be determined by this method without their chemical separation beforehand. A single-crystal γ spectrometer with a 100-channel amplitude analyzer was used. (auth)

3702 CRITICAL REVIEW OF THE ANALYTICAL METHODS OF THE TITANIUM, VANADIUM, AND CHROMIUM TRANSITION ELEMENT GROUPS. Robert Z. Bachman and Charles V. Banks. Progress in Nuclear Energy. Series IX. Analytical Chemistry. Volume 3. Part 4. New York, The MacMillan Co., 1963. 67p. $3.50.

Methods for the determination and separation of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, and W are discussed. 574 references are included. (P.C.H.)

3703 THE ANALYTICAL CHEMISTRY OF COLUMBIUM AND TANTALUM. Galen Porter. p.535-59 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

The determination of Nb and Ta, especially in the presence of each other, is very difficult. Methods for the determination of Nb and Ta are described and evaluated. The methods include gravimetric, titrimetric, spectrophotometric, emission spectrographic, x-ray spectrographic, radiochemical, polarographic, chromatographic, liquid extraction, and ion exchange. The determination of O, H, C, N, Fe, Ti, Si, and other minor impurities in Nb and Ta metals and oxides is described, along with the determination of Nb in Ta and Ta in Nb. A method for the determination of Nb and Ta in columbite ores is described in detail. (M.P.G.)

3704 THE USE OF QUENCHING IN A LIQUID SCINTILLATION COUNTER FOR QUANTITATIVE ANALYSIS. George Vanderkolk Foster. Thesis, Lafayette, Ind., Purdue Univ., 1963. 93p.

Quenching was used to quantitatively determine the amount of quenching agent present. A sealed promethium-147 source was prepared to be used for the count rate determinations. Two methods to determine the amount of quenching agent present in a sample were developed. One method related the count rate of a sample containing a

quenching agent to the amount of quenching agent present. Calibration curves were plotted using both color and chemical quenchers. The quenching agents used were: F.D.C. Orange No. 2, F.D.C. Yellow No. 3, F.D.C. Yellow No. 4, Scarlet Red, acetone, benzaldehyde, and carbon tetrachloride. The color quenchers gave a linear-relationship, while the chemical quenchers gave a non-linear relationship. Quantities of the color quenchers between about 0.008 mg and 0.100 mg can be determined with an error less than 5%. The calibration curves were found to be usable over a long period of time. The other method related the change in the ratio of the count rates in two voltage windows to the amount of quenching agent present. The quenchers mentioned above were used. Calibration curves were plotted for both the color and chemical quenchers. The relationships of ratio versus amount of quencher were non-linear in each case. It was shown that the reproducibility of the count rate and the ratio was independent of the amount of quencher present but was dependent on the count rate. At count rates above 10,000 counts per minute the reproducibility was better than 1%. (TCO)

3705 RAPID DETERMINATION OF YTTRIUM IN AQUEOUS SOLUTIONS CONTAINING DYSPROSIUM AND IN ORE SAMPLES BY NEUTRON ACTIVATION AND γ-RAY SPECTROMETRY. Minoru Okada (Industrial Research Inst., Tokyo); and Yuichiro Kamemoto. 10p. (CONF-285-6)

From 7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963.

In this method, the sample is irradiated in a pile-neutron flux of 3×10^{11} n/cm^2/sec for 14 sec, and γ spectra of the produced Y^{89m} are observed using a cadmium container to reduce interference by Dy^{165m}. Yttrium contents of gadolinite and samarskite have been determined by this method. Possible interferences due to Y^{89m} being produced by Zr^{90}, Zr^{91}, and Nb^{93} reactions and due to O^{20} were examined and found to be small. (D.L.C.)

3706 ANALYSIS OF X-RAY AND OTHER SPECTRA. Peter Duncumb (to T. I. (Group Services) Ltd.). British Patent 940,487. Oct. 30, 1963. Filed June 29, 1961.

A method and apparatus for analyzing radiation spectra are described. The radiation falls on a proportional counter, pulses from which go to a pulse height analyzer. The distribution curve obtained is compared or balanced on an oscilloscope with a curve empirically synthesized from previously recorded curves characteristic of the known elements present. The relative proportions of these latter curves required to match the observed curve gives the proportions of the elements in the materials. (D.C.W.)

3707 METHOD FOR MEASURING FISSIONABLE ISOTOPE CONCENTRATION. Klaus Einfeld (to INTERATOM). Canadian Patent 666,943. July 16, 1963. Priority date Oct. 17, 1959, Germany.

A nondestructive testing method and apparatus are described for determining the concentrations of two or more fissionable isotopes, e.g., U^{235} and Pu^{239}, in reactor fuel. In the method, the fuel is irradiated successively with at least two neutron fluxes of mean energies of 0.025 and 0.3 ev, and the resulting prompt and/or delayed neutrons are measured and used to calculate the concentrations. The number of neutron fluxes used must be at least equal to or greater than the number of fissionable isotopes being measured. Several ways of obtaining the required different neutron fluxes from one source are given. (D.L.C.)

3708 METHODS AND APPARATUS FOR THE INVESTIGATION OF MATERIALS BY RADIATION. Robert S. Codrington (to Schlumberger Well Surveying Corp.). U. S. Patent 3,113,087. Dec. 3, 1963. Filed July 24, 1957.

Apparatus for investigating the chemical properties of an unknown substance disposed in an inaccessible location by radiation is described. The material is exposed to radiation for at least an interval of time sufficient to induce a chemical change in the unknown substance. The result of that chemical change is then detected. The detected result, for example, polymerization, is indicative of or useful in determining the presence of a particular constituent in the unknown substance. (M.C.G.)

Inorganic and Physical Chemistry

3709 (HW-SA-2965) ELECTRON TRANSFER AND 5f → 6d TRANSITIONS IN URANIUM(IV), NEPTUNIUM(IV), PLUTONIUM(IV) HEXAHALIDES. J. L. Ryan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.) and Chr. Klixbuell Joergensen (Cyanamid European Research Inst., Cologny, Switzerland). [Mar. 26, 1963]. 24p.

Absorption spectra of solutions in acetonitrile of tetraethyl ammonium salts of UCl_6^{2-}, UBr_6^{2-}, UI_6^{2-}, $NpCl_6^{2-}$, $NpBr_6^{2-}$, and $PuBr_6^{2-}$ show three types of bands arranged according to increasing half width: (1) internal $5f^q$ transitions showing a large nephelauxetic effect, the wavenumbers in the hexabromides being some 3 to 5% smaller than of the corresponding hexachlorides; (2) $5f^q \rightarrow 5f^{q-1}6d$ transitions indicating that the 5f → 6d orbital energy differences are roughly constant as function of q in contrast to the strong increase in the aqua ions; (3) $\pi^{24}5f^q \rightarrow \pi^{23}5f^{q+1}$ electron transfer bands indicating that the optical electronegativities x_{opt} (corrected for spin-pairing energy and certain effects of L, S, J splitting) are 1.5 for U(IV), 1.75 for Np(IV), and 2.05 for Pu(IV). Further on, the charge separation effects on electron transfer bands are discussed with special regard to uranyl iodide complexes. (auth)

3710 (IS-677) QUANTUM EFFECTS IN THE CALCULATION OF THE TRANSMISSION COEFFICIENT AS APPLIED TO REACTION RATE CONSTANTS. Ronald Bruce Lantz and R. W. Fahien (Ames Lab., Ames, Iowa). May 1963. Contract W-7405-eng-82. 176p.

Quantum effects in the calculation of the transmission coefficient on the basis of the collision theory were found to be important when specific potential energy models were assumed. The fraction of collisions that are effective in reaction as obtained from a consideration of quantum results was typically about one half the fraction obtained classically. Results obtained from each of the potential models could not be considered classical except over an extremely limited temperature range. Over most of the temperature range either effective penetration or reflection was important for each of the potential models used. Effective penetration represents collisions that are effective in reaction with energy less than the activation energy; reflection represents collisions that are ineffective in reaction at an energy exceeding the activation energy. The results of this study could be applied to several different kinds of rate processes including those which are often described by the absolute reaction rate theory. This theory was applied with moderate success to rate processes such as reaction rates, molecular diffusion rates, momentum transport rates in viscous flow for both Newtonian and non-Newtonian fluids, and in other similar rate processes.

Transport properties predicted by the absolute reaction rate theory when quantum effects are neglected are generally higher than those measured experimentally. A correction on the order of magnitude of that found could give good agreement between predicted and experimental transport properties. The prediction of transport properties is not restricted to non-metallic substances but can with minor modification be used for liquid metals. The experimental temperature dependence of the rate constants was found to agree well with the temperature dependence calculated from the addition of quantum results. Experimental data showed many of the qualitative effects that were predicted by calculation. The method by which the quantum results were included allows a great deal of flexibility. Any arbitrary one dimensional potential model may be used. In addition any arbitrary normalized energy distribution can be employed. A finite-width potential model gave fair agreement with experimental results. The use of this model in general gives better results than classical results and should perhaps be used when a more exact potential model is unavailable. The effect of the energy distributions was found to be unimportant. The simple energy distribution model, which restricts effective collisions to those which occur along the line of centers for the reactant molecules, could be used exclusively. A program for the numerical solution of the transmission coefficient from the Schrödinger wave equation was developed. The time necessary to obtain fifty energy points by use of an IBM-7074 would average about ten to fifteen minutes depending upon the spacing used. The integration of the energy distribution weighted with the transmission coefficient generally takes less than five minutes to evaluate the complete temperature dependence. (auth)

3711 (LADC-5718) THE CRYSTAL STRUCTURE OF URANYL DIHYDROXIDE, $UO_2(OH)_2$. R. B. Roof, Jr., Don T. Cromer, and Allen C. Larson (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 15p.

As a result of single crystal structure analysis, the material usually designated as uranium trioxide with one water of hydration, $UO_3 \cdot H_2O$, should be described chemically as uranyl dihydroxide, $UO_2(OH)_2$. The orthorhombic unit cell has the dimensions a = 5.635 ± 0.007, b = 6.285 ± 0.008, and c = 9.919 ± 0.008 Å. There are four formula units per unit cell and the space group was uniquely determined from the systematic extinctions to be Pbca. In the least-squares refinement of the structure, a secondary extinction parameter, real and imaginary portions of the anomalous dispersion, and anisotropic thermal parameters were used. The structure can be described as composed of layers that are hydrogen-bonded together, the hydrogen-bond distance being 2.69 Å. The layers are constructed by octahedra which share corners in order to build and expand the layer. Each octahedron contains a central uranium atom, two uranyl oxygen atoms and four hydroxyl oxygen atoms. (auth)

3712 (LADC-5728) THE Pu–$PuCl_3$ SYSTEM. K. W. R. Johnson and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). Mar. 11, 1963. Contract W-7405-eng-36. 7p.

Phase equilibria in the Pu–$PuCl_3$ system was investigated up to 1180°C. A salt-rich eutectic point exists at 7 mole % Pu and 740°C, which is also the monotectic temperature. The metal-rich eutectic point is at some composition greater than 99 mole % Pu and was too small to be detected. The consolute temperature is sufficiently high to be beyond the scope of this investigation. No evidence for a Pu halide other than $PuCl_3$ was found. (auth)

3713 (ORNL-3470(p.11-15)) SPECTROSCOPY OF IONIC MEDIA. (Oak Ridge National Lab., Tenn.).

The general-purpose multicenter Gaussian and one-center Slater expansion techniques for the computation of electronic wave functions in atoms, molecules, and crystals are being developed. The one-center codes were used in demonstrating that the "split p-orbital" method is unsatisfactory. Absorption spectra of nickel(II) ion, measured in a variety of high-temperature solvents, were interpreted in terms of ligand-field theory. Tetrahedral nickel(II) complexes, which are relatively rare, were identified in molten organic salts, molten potassium chloride, molten cesium chloride, and molten dimethylsulfone with added chloride. It was shown that the nickel(II) ion exists in an octahedral, or distorted octahedral, field when dissolved in molten fluorides. The spectra of nickel(II) ion in oxo salt solvents, such as nitrate and sulfate, actually involve a large rhombic splitting of the orbital states that arise from the free-ion ^3P term, rather than the previously assumed octahedral symmetry. The lowest-energy charge-transfer bands of nitrate and iodide ions were accurately measured in molten-salt solvents for the first time. The effect of cation environment on oscillator strength has been measured for the lowest-energy transition of the nitrate ion. A procedure was devised for calculating the concentrations of the two solute species for a family of solute equilibria of which the simplest is $4Bi^+ \rightleftharpoons Bi_4^{4+}$, which occurs in Bi–$BiCl_3$ solutions. Densities of several pure salts and salt mixtures were measured. (auth)

3714 (ORNL-3470(p.41-4)) X-RAY DIFFRACTION RESEARCH. (Oak Ridge National Lab., Tenn.).

Service functions and research programs of the X-Ray Diffraction Group are reviewed. The determination of crystal structures for mixed-oxide compounds containing BeO and for iron-substituted minerals has progressed. The application of single-crystal diffraction techniques to the problem of radiation damage in BeO has confirmed the general hypotheses derived from powder data and added new details requiring more-sophisticated models of the damaged lattice. An x-ray diffraction experiment with Nb_3Sn showed no thermal instability or order-disorder transition up to 1000°C. (auth)

3715 (TID-7683) PLUTONIUM CHEMISTRY SYMPOSIUM, CHICAGO, ILLINOIS, FEBRUARY 18, 1963. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 44p.

Eight papers are included which discuss topics related to the chemistry of plutonium. The emphasis is on historical aspects, particularly these relating to the early plutonium project, although the nuclear properties of plutonium, the historical program of USAEC, and scaled nuclear power plants are also treated. Separate abstracts were prepared for all the papers. (D.L.C.)

For abstracts of individual papers see: 3716, 3717, 3718, 3719, 4259, 4584, 4802, and 4915.

3716 (TID-7683(p.3-6)) PLUTONIUM. ITS BEGINNINGS. Glenn T. Seaborg (Atomic Energy Commission, Washington, D. C.).

An informal discussion is presented on the first experiments involving plutonium and its discovery. The work on transuranium elements is described. Studies of the chemical behavior of neptunium and plutonium are discussed. Plutonium was first produced by the deuteron bombardment of uranium in Dec. 1940, and was first identified definitely in Feb. 1941. Further studies on neptunium and plutonium are also described, including fission measurements and isolation of plutonium on a microgram scale. Personal reminiscences about the work are given. (D.L.C.)

3717 (TID-7683(p.7-11)) THE FIRST EXPERIMENTS WITH PURE PLUTONIUM COMPOUNDS. Burris B. Cunningham (California. Univ., Berkeley. Lawrence Radiation Lab.).

A first hand account is given of some of the earliest experiments performed with pure plutonium compounds. Ultramicroanalysis was used in these experiments, and the development and calibration of Salvioni ultramicrobalances are discussed. Some of the final operations on the plutonium produced in a cyclotron are described. The results of specific activity and half life measurements on Pu^{239} and of solubility determinations of several plutonium salts in aqueous solutions are given. (D.L.C.)

3718 (TID-7683(p.28-9)) THE DRY CHEMISTRY OF PLUTONIUM. Larned B. Asprey (Los Alamos Scientific Lab., N. Mex.).

A survey is presented of recent work on the dry chemistry of plutonium oxides, carbides, hydrides, halides, borides, and a few miscellaneous compounds. The preparation and physical properties of the compounds are discussed. (D.L.C.)

3719 (TID-7683(p.30-5)) SOLUTION CHEMISTRY OF PLUTONIUM. Kurt A. Kraus (Oak Ridge National Lab., Tenn.).

A survey is presented of the solution chemistry of Pu, along with a brief historical analysis. Among the properties of Pu in solution discussed are the carrier properties, disproportionation reactions, hydrolysis, solvent extraction, complexes, and ion exchange properties. (D.L.C.)

3720 (TID-19736) MASS SPECTROMETRIC STUDY OF THE VAPORIZATION OF URANIUM MONOPHOSPHIDE. K. A. Gingerich and P. K. Lee (Pennsylvania State Univ., University Park). [1963]. Contract AT(30-1)-2541. 30p.

The vaporization of uranium monophosphide, UP, and its mixtures with uranium oxide, UO_2, was investigated by Knudsen effusion techniques in combination with a mass spectrometer. The vaporization of UP occurs by decomposition according to: (1) $UP_{(s)} = U_{(g)} + 1/x\ P_{x(g)}$ (x either 1 or 2). If UO_2 is present approximately in equimolar ratio with UP, the principal reaction is according to: (2) $UP_{(s)} + UO_{2(s)} = 2\ UO_{(g)} + (1/x)\ P_{x(g)}$ (x either 1 or 2). The partial pressures of P, P_2, and U over UP were obtained from the silver calibration for the temperature range of 1750 to 2250°K as follows: $\log p_{atm}\ [P] = -26211/T + 6.6743 \pm 0.0683$, $\log p_{atm}\ [P_2] = -23046/T + 4.5188 \pm 0.1097$, and $\log p_{atm}\ [U] = -28677/T + 7.9313 \pm 0.0709$. From the second law treatment the heat of vaporization kcal per mole of UP is obtained for reaction (1) as 183.96 when x = 2, and 251,17 when x = 1. Vapor pressures derived from other methods, such as (a) from known dissociation energy of P_2 and thermodynamic functions of P and P_2, and (b) from the amounts of sample evaporated are discussed. (auth)

3721 (TIM-696) AN INVESTIGATION OF THE TERNARY SYSTEM, Cb–Li–O. D. E. Fornwalt (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). July 5, 1961. Contract AT(11-1)-229. 7p.

X-ray-diffraction patterns showing at least seven previously unreported phases were obtained from the products formed by the reaction of the binary mixtures, $Li_2O-Nb_2O_5$, Li_2O-NbO_2, Li_2O-NbO, Li_2O-Nb, $LiH-NbO$ in varying compositions. The x-ray data and the identified compounds formed by the reactions are discussed. The structure of the compound $4Li_2O \cdot Nb_2O_5$ was found to be body centered cubic with a cell edge of 8.45 A. (auth)

3722 (UCRL-7167) THE VAPOR PRESSURES OF 30 INORGANIC LIQUIDS BETWEEN ONE ATMOSPHERE AND THE CRITICAL POINT. David G. Edwards (California. Univ., Livermore. Lawrence Radiation Lab.). June 13, 1963. Contract W-7405-eng-48. 151p.

Literature values of the vapor pressures of H_2, HD, D_2, N_2, O_2, Ne, Ar, Kr, Xe, CO, NO, CH_4, SiF_4, N_2O, CO_2, HCl, HBr, HI, SF_6, H_2S, Cl_2, Br_2, NH_3, C_2N_2, SO_2, SO_3, $COCl_2$, HF, HCN, N_2O_4, CCl_4, and $SnCl_4$ were compared with the Kirchhoff formula $\log P_K = -A/T + B$ between the normal boiling point and the critical point, where A and B are determined for each liquid. Plots are presented of the deviations computed by the equation: $d = P_K - P_{obs}$. Based on accurately determined curves for 17 of these substances, empirical hypotheses were developed to allow the prediction of the most probable course of the deviation curve in cases where the data appeared to be unreliable. In addition, where precise data were available, the possibility of the existence of fine structure curvature was demonstrated. The deviation curves were used to obtain tables of interpolated vapor pressure values which are, in most cases, more accurate by one order of magnitude than any now in the literature, particularly where smoothed regression curves do not discriminate between random experimental errors and systematic deviations of an arbitrarily chosen formula from the real vapor pressure curve. Since the deviation curve is invariably shown to approach the zero ordinate at the critical point with a large negative slope, the correspondence between the critical pressure and temperature is fixed with a high degree of confidence. A particular result of this work is that the critical pressure of NH_3 was shown to be about one atmosphere higher than the presently accepted value. The new values for the critical points of CH_4, C_2N_2, HCN, and Br_2 also resolved differences existing between various authorities in the literature. (auth)

3723 (CEA-tr-A-1381) FACTEUR DE SEPARATION DE LA REACTION D'ECHANGE H/D ENTRE EAU ET ETHANE-DITHIOL-1,2. (Separation Factor for the H/D Exchange Reaction Between Water and Ethane-dithiol-1,2). R. [A. W.] Haul and D. Blennemann. Translated into French from Z. Physik. Chem. (Frankfurt), 23: 300-2 (1960). 7p.

A precise determination was made of the H/D separation factor in the water–ethanedithiol-1,2 system. For the measurement of the factor, known quantities of water and ethanedithiol-1,2 were placed in equilibrium in pyrex ampules at different temperatures. The determination of the deuterium concentration on a special 180° mass spectrometer of the water before the reaction and of the dithiol after the reaction permitted a simple calculation of the partition coefficient. The details of the measurement process are given, and the separation factors obtained at different temperatures are tabulated. (J.S.R.)

3724 THE USE OF A SHOCK TUBE FOR EXPLORATORY STUDIES OF HIGH TEMPERATURE EQUILIBRIUM AND REACTION RATES: HYDROGEN–DEUTERIUM EXCHANGE. Martin E. Gluckstein and Stuart W. Churchill (Univ. of Michigan, Ann Arbor). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 9: 821-6(Nov. 1963).

An investigation was made of the possibilities of using a simple shock tube as a tool in the exploratory study of chemical reaction rates and equilibria at high temperatures. The theoretical equilibrium compositions of hydrogen–deuterium mixtures at high temperature were confirmed experimentally. Limited overall rate data were determined for the hydrogen–deuterium exchange reaction in the temperature range from 1000 to 3200°K. It was concluded that a shock tube can be designed and instrumented

to provide precise kinetic data, but the required instrumentation is very expensive. (P.C.H.)

3725 ALKALI HALIDE SOLID SOLUTIONS. III. HEAT OF FORMATION OF THE CESIUM CHLORIDE TYPE. Jaakko Hietala (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, 123: 1-18(1963).

A theory of the heat of formation of solid solutions of the cesium chloride structure is presented. The heat of formation curve was found to be very nearly a simple second-degree parabola when described as a function of crystal composition. (P.C.H.)

3726 THERMODYNAMIC PROPERTIES OF CARBON DIOXIDE IN THE TEMPERATURE RANGE FROM 0 TO 1000°C AND AT PRESSURES UP TO 100 BAR. M. P. Vukalovich, V. V. Altunin, and N. I. Timoshenko. At. Energ. (USSR), 15: 210-14(Sept. 1963). (In Russian)

For many reasons, CO_2 is considered as the most promising heat transfer agent in gas turbines of atomic power stations; therefore, its density was previously determined at various temperatures and pressures by the authors (Teploenergetika No. 11, 58(1959); No. 5, 56(1962); No. 1, 85 & No. 2, 92(1963)). The values reported in those papers were used for thermodynamic calculations of the equation of state. Heat capacity, enthalpy, and entropy values were computed for temperatures between 0 and 1000°C and pressures between 1 and 100 bar. Data reported by H. Wooley (J. Res. Nat. Bur. Stand. 52, 289(1954)) were also included in the calculations. The values obtained are considered to lie closer to the true values than those derived by V. Schrock (National Advis. Comm. f. Aeronaut., Tech. Note No. 2838(1952)). The entropy data also agree with earlier findings and with the values given in NBS Circular No. 564 within 0.05%, except in the pressure range beyond 70 bar where the NBS data are lower by as much as 0.15%. (TTT)

3727 INVESTIGATION OF THE HIGH-TEMPERATURE VOLATILIZATION MECHANISM OF RUTHENIUM COPRECIPITATED WITH VARIOUS DEPOSITS. Yu. N. Golovanov, N. E. Brezhneva, S. N. Oziraner, A. A. Eremin, and V. L. Zotov. At. Energ. (USSR), 15: 219-24(Sept. 1963). (In Russian)

During the transformation of radioactive waste liquors into solids by incorporating them into glasses and ceramic materials or by calcining the residue from evaporation, a large portion of the Ru is volatilized. The volatilization rate depends on the temperature, the duration of the soaking, and the compositions of the gaseous and solid phases. The process is due to the oxidation of Ru to its tetravalent form. Tests were carried out with suspensions of various hydroxides coprecipitated with Ru, using Ru^{106} as tracer. The suspension was dried at 80°C and the activity of the residue determined by means of a β counter; this counting operation was repeated after exposure to elevated temperatures for calculating the amount volatilized. The material was heated at a rate of 6.7°C/min, soaking at 1200°C for 15 minutes. Tests with coprecipitated Cr and Fe oxides heated under an Ar blanket showed an absence of volatility of the Ru. In air, the volatilization, due to the formation of RuO_4, was found to start at 750°C with both Fe_2O_3 and Cr_2O_3. Tests were also made with binary systems consisting of Fe_2O_3 and CaO or SiO_2. The results indicated that 3 stages are included in the volatilization reaction: direct volatilization of Ru from the surface of the particles according to a monomolecular reaction; a transition stage and finally, a diffusion stage. In the case of the binary mixtures, the volatilization follows the liquidus line, reaching its maximum at the lowest melting temperature. (TTT)

3728 STUDY OF THE HIGH-TEMPERATURE VOLATILIZATION MECHANISM OF CESIUM, COPRECIPITATED WITH DOUBLE FERROCYANIDE OF NICKEL AND POTASSIUM. Yu. N. Golovanov, N. E. Brezhneva, S. N. Oziraner, A. A. Eremin, and V. L. Zotov. At. Energ. (USSR), 15: 261-2(Sept. 1963). (In Russian)

Using a previously described method, Cs, containing Cs^{137} for labeling, was coprecipitated with $K_4Ni_4[Fe(CN)_6]$, a reagent used for removing Cs from waste liquors. Heating the double ferrocyanide in air resulted in the volatilization of Cs at temperatures beyond about 575°C; at 900°C the element was completely volatilized. Under Ar atmosphere the rate of volatilization was higher than in air because of the increased volatility of the metallic Cs. Additions of NiO, CaO, CaF_2, Na_2CO_3, SiO_2, Al_2O_3, Fe_2O_3, or Cr_2O_3 to the mixture of Cs oxide and the coprecipitated double ferrocyanide were found to reduce the Cs losses upon heating to 800°C for 30 minutes, with the exception of Na_2O (from the Na_2CO_3) which had the opposite effect. The effectiveness of the additives decreased in the following order: $Cr_2O_3 \rightarrow Fe_2O_3 \rightarrow Al_2O_3 \rightarrow SiO_2$. The first 3 of these inhibitors have a rhombic structure; the other additives were cubic. The ability of Fe_2O_3 to retain Cs in the solid phase was used to suppress volatilization completely; this was found possible only up to 1000°C. The system consisting of ferrocyanide + SiO_2 + Fe_2O_3, forming a heat-resistant mixture was found to bind the Cs irreversibly; a composition of $Fe_2O_3 : SiO_2$: ferrocyanide in the ratio of 7 : 5 : 1 retained the Cs in the solid phase even at 1200°C. (TTT)

3729 CALCULATION OF THE THERMODYNAMIC PROPERTIES OF CESIUM VAPORS AT TEMPERATURES UP TO 1500°K AND AT PRESSURES UP TO 22 BAR. N. I. Agapova, B. L. Paskar', and L. R. Fokin. At. Energ. (USSR), 15: 292-302(Oct. 1963). (In Russian)

The thermodynamic properties of wet and superheated Cs vapors are tabulated in the indicated temperature and pressure range, using a method previously employed for determination of similar properties of K (M. P. Bukalovich et al. Teploenergetika No. 8, 10(1962)). It was assumed for the calculations that the Cs vapor consists of an equilibrium mixture of the monoatomic and diatomic ideal gases $Cs_2 \rightleftharpoons 2Cs_1$ while the wet vapor was assumed to represent a gasodynamically homogeneous medium. While determining the properties of the saturated vapor, the specific volume and the compressibility of the liquid were neglected. The values tabulated include the dissociation pressure, degree of dissociation, molecular mass of the vapor, its specific volume, the specific entropy and enthalphy values, heat of evaporation, heat capacity, the differential adiabatic throttle effect, the velocity of sound in the medium, and the adiabatic index. The calculated absorption pressure of Cs vapors at 400°K was about 30% lower and at 1500° about 30% higher than the values obtained by An. N. Nesmeyanov's formula (The vapor pressure of chemical elements, published by the USSR Acad. of Sciences, 1961); this is due to the differences in the heat of sublimation values used. The acoustic and thermal adiabatic indicators were found to diverge by 20 to 30%. The degree of ionization of the $Cs = Cs^+ + e^-$ reaction, $\alpha \cong 2 \times 10^{-5}$. (TTT)

3730 DISPLACEMENT OF URANIUM BY ZINC FROM CHLORIDE MELTS. I. F. Nichkov, S. P. Raspopin, and A. F. Tsarenko. At. Energ. (USSR), 15: 336-7(Oct. 1963). (In Russian)

The reduction of U^{4+} ions was studied by exploring the interaction of UCl_4 with metallic Zn in a mixture of molten alkali chlorides. An equimolar mixture of NaCl and KCl containing the desired amount of UCl_4 was used for the

experiments. The starting materials and the He blanket gas were purified carefully before use. In order to follow the rate of the interaction, the potential of Zn immersed in the salt mixture was determined against a Pb reference electrode. The measurement was terminated when after 60 minutes the potential did not change more than 1 mv. It was found that an insoluble deposit was formed at the interface between the solified electrolyte and the Zn, while the U concentration of the salt mixture was reduced to zero. The Zn was found to form Zn^{2+} ions in the chloride melt. The atomic ratio of U : Zn in the deposit was about 1.5; in the reaction zone this ratio was about 1.2; this allowed derivation of the following displacement reaction: $3U^{4+} + 2\frac{1}{2}Zn + 11Cl^{-} \rightarrow 3UCl_3 \cdot 2ZnCl + \frac{1}{2}Zn^{2+}$. The time required for establishment of the equilibrium was found to be directly proportional with the U content of the melt; it appears probable that the reaction rate is controlled by the transfer rate of U^{4+} ions to the surface of the Zn through the diffusion layer of the electrolyte. (TTT)

3731 TEMPERATURE DEPENDENCE OF INFRARED ABSORPTION SPECTRUM OF HEAVY WATER. Kaoru Taniguchi (Japan Atomic Energy Research Inst., Tokyo). Bunko Kenkyu, 11: 217-27(June 1963). (In Japanese)

Infrared absorption by heavy water was measured in the range 25 to 80°C and comparison was made between 3μ and 4μ absorption bands in regard to temperature dependence. The results are discussed on the bases of ice-structure breakdown in liquid water and the difference in molecular association between H_2O and D_2O. (auth)

3732 SECOND SYSTEM OF THE ARC SPECTRUM OF PLUTONIUM. NEW EVEN LEVELS OF THE I AND II SPECTRA AND THE IONIZATION POTENTIAL OF PuI. Jacques Bauche, Jean Blaise, and Mark Fred (CNRS, Bellevue, France and Argonne National Lab., Ill.). Compt. Rend., 257: 2260-3(Oct. 14, 1963). (In French)

A second system of levels belonging to $5f^6 6d 7s^2$, $5f^6 6d^2 7s$, $5f^6 7s^2 7p$, $5f^6 6d 7s 7p$, and $5f^6 6d^2 7p$ configurations were established experimentally in the spectrum of Pu I; the theoretical study of the $5f^6 6d 7s^2$ was begun. The ground level of this second system is placed at 6313.6 K above $5f^6 7s^2\ ^7F_0$. The energies of the new even levels of the I and II spectra were indicated. The ionization potential of Pu I is about 5.8 v. (tr-auth)

3733 NUCLEAR MAGNETIC RESONANCE STUDY OF THE H_2 AND HD MOLECULES IN THE GASEOUS STATE. Elie Dayan, Gérard Widenlocher, and Marcel Chaigneau (CNRS, Bellevue, France and CNRS, Paris). Compt. Rend., 257: 2455-7(Oct. 21, 1963). (In French)

The J effect of the HD molecule, the intermolecular actions as a function of the pressure of the H_2 and HD molecules, and the measurement of the difference ($\Delta\sigma$) of the shielding constants of H_2 and HD were defined experimentally. (tr-auth)

3734 THE POLYMORPHISM OF LANTHANUM OXIDE. V. B. Glushkova and E. K. Keler (Grebenshchikov Inst. of Silicate Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 611-14(Sept. 21, 1963). (In Russian)

An attempt was made to obtain the low-temperature C form of La_2O_3 by decomposing the carbonate, oxalate, hydroxide, and nitrate salts in a vacuum of 1×10^{-3} to 1×10^{-4} mm Hg std. Only the high-temperature A form of La_2O_3 was obtained on previous attempts to prepare the C form of La_2O_3 by decomposition of a salt. The decomposition of lanthanum oxalate and lanthanum carbonate in vacuum led to the formation of an amorphous product containing a significant amount of carbon. The low-temperature C form of La_2O_3 was observed at 550°C, but the C form was slowly converted to the A form of La_2O_3. Decomposition of lanthanum nitrate in vacuum gave the most crystalline samples of the C form of La_2O_3. The low-temperature C form has a fluorite type of lattice with a = 11.36 ± 0.02 Å, and the high-temperature A form of La_2O_3 is hexagonal with a = 3.937 Å, c = 6.130 Å, and c/a = 1.56. The C form is readily converted to the A form of La_2O_3 on heating in vacuum or in dry oxygen at a temperature above 550°C. (TTT)

3735 THE ELECTRICAL PROPERTIES OF LANTHANUM AND CERIUM SESQUISULFIDES. G. V. Samsonov and V. I. Marchenko (Inst. of Cermets and Special Alloys, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 152: 671-3(Sept. 21, 1963). (In Russian)

Samples of La_2S_3 and Ce_2S_3 with a residual porosity of 13 to 18% were prepared by sintering in a H_2S atmosphere. The electrical resistance and thermal emf were measured from 100 to 1000°C. Both sulfides are p-type, impurity semiconductors. The transition temperature for a particular type of conductivity is 600 to 700°C for La_2S_3 and 670 ± 50°C for Ce_2S_3. The impurity activation energy ΔE_{imp} is 0.32 ev for La_2S_3 and 0.25 ev for Ce_2S_3. The width of the forbidden zone ΔE_0 is 1.32 ev for La_2S_3, and 1.12 ev for Ce_2S_3. The positive thermal emf is given by the formula $\alpha_t = +86[(\Delta E_{imp}/2kT) - 1.98]$ for La_2S_3, and by the formula $\alpha_t = \Delta E_{imp}/2kT$ μV/deg for Ce_2S_3. The negative thermal emf is directly proportional to the temperature, and is given by the following empirical formulas: $\alpha_t = -[250 + 3(t - 800)]$ μV/deg for La_2S_3, and $\alpha_t = -4(t - 800)$ μV/deg for Ce_2S_3. The thermoelectric factor of merit for the lanthanum and cerium sesquisulfides is approximately equal to $Z_{1200°} = 10^{-3}$ deg^{-1}. (TTT)

3736 PRODUCTION OF URANIUM TETRAFLUORIDE IN A FLUIDIZED BED REACTOR. E. Chapela Lago and A. Rodrigo Otero (Junta de Energia Nuclear, Madrid). Energia Nucl. (Madrid), 7: No. 27, 21-9(July-Sept. 1963). (In Spanish)

The experience gained in the reduction of uranium trioxide in a fluidized bed was used to design, construct, assemble, and put into operation a batch fluoridation installation for the production of uranium tetrafluoride. The system, reagents and products, operation, safety, and the installation are described in detail. (J.S.R.)

3737 NUCLEAR THORIUM — OXIDE AND METAL. P. Rombau. Energie Nucl., 5: 441-5(Sept.-Oct. 1963). (In French)

Two principal minerals provide the industrial sources of thorium: uranothorianite and monazite. Nuclear thorium, in oxide or metal form, is prepared from monazite; the process that is used to obtain the rough hydroxide, the nitrate, the oxide, and the metal is described. Following the chemical processes come the metallurgical operations: sintering of the metal powder (giving pellets), and conversion of the pellets into bars or ingots. (auth)

3738 OXYGEN-18 TRACER STUDIES ON THE REDUCTION OF URANYL ION BY CHROMIUM(II). Gilbert Gordon (Univ. of Maryland, College Park). Inorg. Chem., 2: 1277-80(Dec. 1963).

Oxygen-18 tracer experiments were carried out on the reaction between UO_2^{2+} and Cr(II) in aqueous perchloric acid. Evidence is presented suggesting efficient transfer of oxygen from UO_2^{2+} to Cr(II) under conditions where the reaction between the excess Cr(II) and intermediate is rapid. The results of oxygen-transfer experiments are given at 0 and 25°. The results at 25° and low H^+ are interpreted in terms of an activated complex containing Cr–O–U–O–Cr bonds. (auth)

3739 THE REACTIONS OF URANIUM HEXAFLUORIDE WITH HYDROGEN SULFIDE AND WITH CARBON DISULFIDE. L. E. Trevorrow, Jack Fischer, and W. H. Gunther (Argonne National Lab., Ill.). Inorg. Chem., 2: 1281-4(Dec. 1963).

Uranium hexafluoride reacts with hydrogen sulfide at 25° to produce uranium tetrafluoride, sulfur tetrafluoride, and hydrogen fluoride. Uranium hexafluoride reacts with carbon disulfide vapor at 25° to produce uranium tetrafluoride, sulfur tetrafluoride, bistrifluoromethyl disulfide [$(CF_3)_2S_2$], and bistrifluoromethyl trisulfide [$(CF_3)_2S_3$], and at elevated temperatures the reaction also produces sulfur hexafluoride and tetrafluoromethane, CF_4. When uranium hexafluoride vapor reacts with carbon disulfide vapor at 25° in the presence of helium as a diluent, the favored perfluoroalkyl product is bistrifluoromethyl trisulfide. Uranium hexafluoride was compared with other metal fluorides with respect to their reactions with carbon disulfide. (auth)

3740 INTERACTION ENERGIES AND TRANSPORT COEFFICIENTS OF Li + H AND O + H GAS MIXTURES AT HIGH TEMPERATURES. Paul H. Krupenie (National Bureau of Standards, Washington, D. C.); Edward A. Mason, and Joseph T. Vanderslice. J. Chem. Phys., 39: 2399-2408(Nov. 15, 1963).

Accurate potential energy curves for the $X^1\Sigma_g^+$, $A^1\Sigma_u^+$, $B^1\Pi_u$, and $C^1\Pi_u$ states of the Li_2 molecule were calculated from observed spectroscopic data by the method of Rydberg-Klein-Rees (RKR), and compared with previous quantum-mechanical calculations. Long-range attractive potentials were estimated by extrapolation of functions fitted to the RKR ground-state curves of Li_2, LiH, and OH. From these, the repulsive potentials derivable from interacting ground-state atoms were estimated semiempirically. Collision integrals were computed from the potentials, and transport coefficients of the gaseous systems Li + Li, Li + H, and O + H were calculated for temperatures of 1000 to 10000°K. A surprising result was the extraordinarily large values of the collision integrals for Li + Li (and Li + H) interactions, which result in unexpectedly small values of diffusion coefficient, viscosity, and thermal conductivity. For traces of Li in Li + H mixtures at low temperature, the thermal diffusion factor was very large. Various approximate formulas for viscosity and thermal conductivity of mixtures were seen to give poor agreement with exact calculations for the systems considered. (auth)

3741 INFRARED SPECTRA AND THE STRUCTURES AND THERMODYNAMICS OF GASEOUS LiO, Li_2O, AND Li_2O_2. David White (Ohio State Univ., Columbus), K. S. Seshadri, D. F. Dever, D. E. Mann, and M. J. Linevsky. J. Chem. Phys., 39: 2463-73(Nov. 15, 1963).

The vapor above heated lithium oxide (Li_2O) was investigated mass spectrometrically and by infrared matrix-isolation spectroscopy. The vapor composition and Knudsen effusion rates were measured as functions of temperature, and the matrix spectra of the principal lithium oxide species—Li_2O, LiO, Li_2O_2—identified and analyzed for different isotopic abundances. The predominant vapor species Li_2^7O is probably linear with r(Li–O) = 1.59 Å, and has fundamentals ν_1, ν_2, ν_3 at [760], [140], and 987 cm^{-1}, respectively. Its heat of formation $\Delta H_0°(f) = -43.7 \pm 2.5$ kcal/mole. The diatomic molecule Li^7O has $\nu = 745$ cm^{-1}, an estimated bond length r = 1.62 Å, and $\Delta H_0°(f) = +16.5 \pm 5$ kcal/mole. The previously undetected molecule $Li_2^7O_2$ is shown to resemble the alkali halide dimers in having a planar rhombic (V_h) structure for which the O–Li–O angle and Li–O bond length are estimated to be 116° and 1.90 Å, respectively. Its B_{2u} and B_{3u} frequencies are found at 324 and 522 cm^{-1}, respectively, in a krypton matrix. The remaining unobserved modes are estimated in cm^{-1} as follows: $\nu_1(A_g) = 400$, $\nu_2(A_g') = 250$, $\nu_3(B_{1g}) = 300$, $\nu_4(B_{1u}) = 270$. Its $\Delta H_0°(f) = +27.5 + 6$ kcal/mole. (auth)

3742 NEON–HYDROGEN ION-MOLECULE REACTIONS. T. F. Moran and L. Friedman (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 39: 2491-2500(Nov. 15, 1963). (BNL-7084)

Ion-molecule reactions producing NeH^+ in a Ne–H_2 mixture subjected to electron bombardment in the ion source of a mass spectrometer were studied. Ionization-efficiency curves show that NeH^+ is primarily formed by reaction of H_2^+ and Ne. The calculated rate constant is in good agreement with theory when only H_2^+ ions in the second or higher vibrational levels are considered as reactant. The energetic requirements of reaction appear to be satisfied exclusively by internal energy of H_2^+. At higher ion-source pressures NeH^+ is formed in a third-order process, which was found to be first order in hydrogen and second order in neon pressure. The ionization-efficiency curve of the third-order NeH^+ closely resembles a Ne^* metastable excitation curve. Results suggest a Ne^*–H_2 interaction producing a highly excited hydrogen molecule which subsequently ionizes to H_2^+ and then reacts with Ne producing NeH^+. The H_2^+–He ion molecule reaction served as a sensitive probe to show that Ne^*–H_2 collisions produce H_2^+ in vibrationally excited states with $\nu \geq 5$. A momentum-transfer cross section calculated for the metastable atom-molecule interaction is in reasonable agreement with the measured cross section. (auth)

3743 DISSOCIATIVE CHARGE-EXCHANGE REACTIONS OF RARE-GAS IONS WITH PROPANE. Jean H. Futrell and Thomas O. Tiernan (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Chem. Phys., 39: 2539-45(Nov. 15, 1963).

Dissociative charge-exchange reactions of rare-gas ions with propane and with partially deuterated propanes were investigated using a modified commercial mass spectrometer. The experimental results for propane are in good agreement with data previously obtained using much more sophisticated instrumentation. Charge-exchange spectra obtained with 2,2-dideuteropropane and with 1,1,1,3,3,3-hexadeuteropropane permit the determination of details of the fragmentation mechanism. The data suggest that both s-propyl and n-propyl ions are formed by charge exchange, but that the latter is a relatively unimportant process. Ethylene is formed chiefly by 1,3 elimination of methane from the molecule ion, but 1,2 elimination becomes relatively more important with increasing recombination energy of the rare-gas ion. In contrast to observations on the vacuum uv photolysis of deuterated propanes, the data indicate that elimination of molecular hydrogen as HD is of substantial importance in the over-all ionic decomposition of both compounds. (auth)

3744 INFRARED SPECTRA OF MOLTEN SALTS. J. K. Wilmshurst (Union Carbide Corp., Parma, Ohio). J. Chem. Phys., 39: 2545-8(Nov. 15, 1963).

An emission technique for the study of the infrared absorption spectra of high-temperature liquids is described, and absorption spectra obtained by the technique for silver chloride and sodium nitrate, using two possible sampling arrangements, are compared with those obtained from reflectivity data. Absorption spectra derived from infrared reflectivity data are presented for the systems LiF–KF, LiF–KF–ZrF_4, and NaF–KF–ZrF_4. Interpre-

tation of the spectra is consistent with the assumption of a complex zirconium species in the latter systems. (auth)

3745 SULFUR AND SILICON ISOTOPE EFFECTS IN FLUORINE NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. R. J. Gillespie and J. W. Quail (McMaster Univ., Hamilton, Ont.). J. Chem. Phys., 39: 2555-7(Nov.15, 1963).

Satellites due to fluorine on S^{33} were observed in the F^{19} NMR spectrum of sulfur hexafluoride. Values of the $S^{33}-F$ coupling constant and of the S^{33} isotope effect on the fluorine chemical shift were obtained from the spectrum. We have also observed a S^{34} isotope effect on the fluorine chemical shift of sulfur hexafluoride and other sulfur-fluorine compounds. A Si^{29} isotope effect on the fluorine chemical shift was observed for silicon tetrafluoride. (auth)

3746 EPR SPECTRA OF SH, SD, AND SO RADICALS IN THE GASEOUS STATE. C. C. McDonald (E. I. du Pont de Nemours Co., Wilmington, Del.). J. Chem. Phys., 39: 2587-9(Nov. 15, 1963).

A 12-line EPR spectrum at a microwave frequency of 8.850 kMc/sec was observed in the field region from 7400 to 7700 G that is attributed to electric-dipole transitions between Zeeman levels of the $J = {}^3/_2$ rotational state of gaseous $SH(^2\Pi_{3/2})$. Average Λ splittings and proton hyperfine splittings were 190 G and 5.4 G, respectively. The SH radicals were produced in the spectrometer cavity by adding H_2S at the cavity entrance to a stream of discharge-dissociated H_2O vapor flowing through the cavity. When H_2S was added to a stream of dissociated D_2O, an additional spectrum attributed to $SD(^2\Pi_{3/2}, J = {}^3/_2)$ was observed. Another species in the gaseous systems gives rise to a third EPR spectrum that is believed to result from electric-dipole transitions between Zeeman levels of different rotational states of $SO(^3\Sigma)$. (auth)

3747 NUCLEAR MAGNETIC SHIELDING CONSTANTS AND X-RAY ATOMIC SCATTERING FACTORS FOR TWO-, THREE-, AND FOUR-ELECTRON SYSTEMS BY MEANS OF ANALYTIC HARTREE-FOCK WAVEFUNCTIONS. M. L. Rustgi and P. Tiwari (Banaras Hindu Univ., Varanasi, India). J. Chem. Phys., 39: 2590-3(Nov. 15, 1963).

Nuclear magnetic shielding constants and x-ray atomic scattering factors were calculated for two-, three-, and four-electron systems using the best analytical self-consistent field functions of Roothaan, Sachs, and Weiss, and where possible, the reported values were compared with the ones already published. It is pointed out that it may not be possible to extract any reliable information about the angular and radial correlations of electrons in the atoms and ions considered here from the scattering factors. (auth)

3748 CONFORMAL IONIC MIXTURES. Milton Blander (North American Aviation Science Center, Canoga Park, Calif.) and S. J. Yosim. J. Chem. Phys., 39: 2610-16(Nov. 15, 1963).

The excess free energy of mixing of molten reciprocal salt solutions (A^+, B^+, X^-, Y^-) was calculated up to the second order by perturbation method previously described. The result is a power series containing integral powers of the ion fractions (concentrations). This demonstrates that mixtures of two salts of the same valence type cannot be considered as a mixture of a salt with a dielectric solvent. The first term in the series is proportional to the free-energy change for the reaction $AX + BY \rightarrow AY + BX$. The results of the symmetric approximation based upon the quasilattice model are consistent with the first term and one of the second-order terms. The remaining second-order terms are related to the excess free energy of mixing in the binary systems AX–AY, BX–BY, AX–BX, AY–BY and are of a form first suggested by Førland. This theory, thus, given a relatively rigorous justification to aspects of previous theories of reciprocal salt solutions that were based upon restrictive models and assumptions. (auth)

3749 ISOTOPE BANDS AND THE VIBRATION ASSIGNMENT OF THE $D^2\Pi_g - A^2\Pi_u$ SYSTEM OF N_2^+. T. Namioka, K. Yoshino, and Y. Tanaka (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chem. Phys., 39: 2629-33 (Nov. 15, 1963).

The $D^2\Pi_g - A^2\Pi_u$ bands of $(N_2^{15})^+$ were studied in the 2050 to 2570-Å region in order to determine the correct vibrational quantum number assignment. The results obtained from the study of the isotope shifts of the band heads show that the quantum number of the previously observed lowest vibration level of the D state is v = 3. The potential energy curve of the D state was also calculated. (auth)

3750 OPTIMIZED SINGLE-CONFIGURATION WAVEFUNCTION FOR THE GROUND STATE OF LITHIUM FLUORIDE. A. D. McLean (IBM Corp., San Jose, Calif.). J. Chem. Phys., 39: 2653-65(Nov. 15, 1963).

A single-configuration self-consistent-field molecular orbital wavefunction for the $^1\Sigma$ ground state of lithium fluoride from which a total molecular energy of −106.9885 au at an internuclear separation of 2.887 au can be calculated is reported. It is shown on the basis of correlation energy arguments that this energy is within 0.007 au of the Hartree-Fock energy for the ground state of this molecule. Results computed with wavefunctions of slightly lower accuracy (−106.9769 au at minimum in the computed potential energy curve) are reported over a range of internuclear separations from 1.6 to 4.85 au. The systematic approach used in obtaining the best wavefunction is described, since it appears to be a reasonable approach from the point of view of minimizing the amount of calculation involved, and for molecular wavefunctions this is a crucial consideration. A comprehensive table of expectation values including the dipole moment, kinetic energy T, potential V, $\Sigma_i r^2_{Li,i}$, $\Sigma_i 1/r_{Li,i}$, $\Sigma_i 1/r_{F,i}$, $\Sigma_{i<j} 1/r_{ij}$, and $\Sigma_i (3z^2_{Li,i} - r^2_{Li,i})$ computed with wavefunctions of varying degrees of approximation is given. (auth)

3751 NATURE OF THE HYDROGEN BOND IN SODIUM ACID FLUORIDE. Barbara L. McGaw and James A. Ibers (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 39: 2677-84(Nov. 15, 1963). (BNL-7194)

Neutron diffraction data, obtained from single crystals of $NaHF_2$ and $NaDF_2$, were analyzed in terms of several models for the bifluoride ion geometry. In sodium acid fluoride the bifluoride ion must be linear and the two fluorine atoms equivalent. The F–H–F distance is 2.264 ± 0.003 Å, the F–D–F distance is 2.265 ± 0.007 Å. From the diffraction data alone it is impossible to distinguish between a symmetric model for the bifluoride ion and one in which the potential for the hydrogen (or deuterium) along the bond has two equal minima on either side of the center. However from a comparison between the differences of mean-square amplitudes of vibration of hydrogen (or deuterium) and fluorine as obtained from the analysis of the diffraction data and as calculated from the spectroscopic frequencies it was concluded that the bifluoride ion is indeed symmetric. (auth)

3752 ENHANCEMENT OF FLUORESCENCE YIELD OF RARE-EARTH IONS BY HEAVY WATER. John L. Kropp and Maurice W. Windsor (Space Tech. Labs., Re-

dondo Beach, Calif.). J. Chem. Phys., 39: 2769-70(Nov. 15, 1963).

Experiments on the fluorescence yield of rare earth ions showed that the substitution of deuterated water for ordinary protonated water markedly increases the light yield in most cases. The effect seems to be inversely dependent upon the energy gap between the highest level of the ground multiplet and the resonance level of the rare earth ion from which emission occurs. Thus, the order of magnitude of change of emission intensity is $Eu^{3+} > Tb^{3+} > Gd^{3+}$, while the energy gaps between the resonance level and the high-lying ground level for the same ions are 12 300, 14 200, and 32 100 cm^{-1}, respectively. (P.C.H.)

3753 ABSORPTION SPECTRA OF $Er(C_2H_5SO_4)_3 \cdot 9H_2O$ AND $Yb(C_2H_5SO_4)_3 \cdot 9H_2O$. Eugene Y. Wong (Univ. of California, Los Angeles). J. Chem. Phys., 39: 2781-2(Nov. 15, 1963).

The absorption spectra of $Er(C_2H_5SO_4)_3 \cdot 9H_2O$ and $Yb(C_2H_5SO_4)_3 \cdot 9H_2O$ were taken between 0.9 and 1.1 μ at liquid nitrogen and liquid helium temperature. Data are tabulated. (P.C.H.)

3754 CRYSTAL STRUCTURE OF CERIUM MAGNESIUM NITRATE HYDRATE. Allan Zalkin, J. D. Forrester, and David H. Templeton (Univ. of California, Berkeley). J. Chem. Phys., 39: 2881-91(Dec. 1, 1963). (UCRL-10902)

According to single-crystal x-ray diffraction data, crystals of $Ce_2Mg_3(NO_3)_{12} \cdot 24H_2O$ are rhombohedral, space group $R\bar{3}$. The hexagonal cell with a = 11.004 ± 0.006, c = 34.592 ± 0.012 Å contains three formula units. Atomic parameters were refined by least squares, and interatomic distances were corrected for thermal motion. The average N–O bond distance in nitrate is 1.26 Å. The Ce atoms, on the threefold axis at z = ±0.2497, are each surrounded by 12 oxygen atoms at an average distance of 2.64 Å. The oxygen atoms, belonging to six nitrate ions, are at the corners of a somewhat irregular icosahedron. The Mg atoms are of two kinds, located, respectively, at the origin and on the threefold axis at z = ±0.4279. Each Mg atom is surrounded by six water molecules with the oxygen atoms at the corners of an octahedron with an average Mg–O distance of 2.07 Å. One-fourth of the water molecules are not coordinated to cations. Evidence for the hydrogen atom positions from the diffraction data indicates that six of the eight independent hydrogen atoms are involved in normal hydrogen bonds. (auth)

3755 ANTIFERROMAGNETIC AND CRYSTAL STRUCTURE OF LITHIUM CUPRIC CHLORIDE DIHYDRATE. S. C. Abrahams and H. J. Williams (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 39: 2923-33 (Dec. 1, 1963).

A neutron-diffraction study of $LiCuCl_3 \cdot 2H_2O$ in the temperature range 1.4–5.1°K, together with a magnetic susceptibility study in the range 1.4–300°K, determined its magnetic and crystal structure. The crystal contains linear Li–Cu–Cu–Li, planar $Li_2Cu_2Cl_8$ groups. Each cation is at the center of a distorted octahedron, of composition $LiCl_3O_3$ and $CuCl_4O$: the four octahedra share Cl–Cl edges. The most important distances in the complex are Cu–Cl at 2.25, 2.34, and 2.96 Å; Cu–O at 2.56 Å; Li–O at 2.04 and 2.18 Å; Li–Cl at 2.44 and 2.97 Å; Li–Cu at 3.34 Å; and Cu–Cu at 3.47 Å. The nonbridging Cl atoms in the $Li_2Cu_2Cl_8$ group form OH···Cl bonds of 3.17 and 3.26 Å to other complexes in the crystal. The spins ($S = {}^1/_2$) on the Cu^{2+} within each complex are antiparallel and lie on the 3.47-Å Cu–Cu internuclear line. The spin-density maximum is displaced 0.15 Å from the nearest neighbor Cu^{2+} of opposite spin. The neutron-scattering data indicate $d_{x^2-y^2}$ to be the ground-state orbital. Above a critical field H_c = 9kO2, spin flopping similar to that in $CuCl_2 \cdot 2H_2O$ takes place. (auth)

3756 DEUTERIUM KINETIC ISOTOPE EFFECT IN THE HYDROGEN–IODINE REACTION. John H. Sullivan (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 39: 3001-9(Dec. 1, 1963). (LADC-5865)

Rates of reaction of deuterium with iodine were measured in the range 633°–800°K. The elementary reactions are given. The three independent constants, k_1, k_3, k_4/k_5, in $(mole/cc)^{-1}sec^{-1}$, are given by $\log (k_1/T^{1/2}) = 12.50 - 40\,790/4.575T$, $\log (k_3/T^{1/2}) = 12.41 - 33\,770/4.575T$, and $k_4/k_5 = 0.073$. From a comparison of these with previously obtained rates in the H_2 system, the kinetic isotope effects for the first and third reactions are: $\log (_H k_1/_D k_1) = 0.225 + 150/4.575T$, and $\log (_H k_3/_D k_3) = 0.124 + 1020/4.575T$. The results for the third reaction were fitted to absolute rate theory including tunneling (unsymmetrical Eckart barriers) to obtain permissible ranges of tunneling factors and vibrational frequencies of the linear IH_2 complex. Internuclear distances in triangular IH_2 complexes were found to be only slightly greater than $r_e(HI) = 1.60$ Å and $r_e(H_2) = 0.74$ Å. Sato energy surfaces were calculated for a number of Sato parameters; tunneling for the surfaces was found to be negligible when computed from Eckart potentials fitted to the Sato surfaces. Agreement of theory with experiment could not be obtained for both the preexponential factor and the activation energy of $I + H_2$ for any value of the Sato parameter. (P.C.H.)

3757 ISOTOPIC THERMAL-DIFFUSION FACTOR OF ARGON. R. Paul, A. J. Howard, and W. W. Watson (Yale Univ., New Haven). J. Chem. Phys., 39: 3053-6(Dec. 1, 1963).

An extensive investigation of the isotopic thermal-diffusion factor α_0 of argon in the mean temperature range 127 to 653°K was carried out with a four-tube swing separator employed previously in similar work with helium and neon. Because of a linear variation of α_0 with T in the low-temperature region, the mean temperature $\overline{T} = (T_2 - T_1)/\ln(T_2/T_1)$ was used instead of the arithmetic mean of T_1 and T_2. This temperature assignment was verified by varying the temperature gradient significantly. The experimentally determined value of α_0 increases from 0.068 ± 0.015 at $\overline{T}$ = 127°K to 0.485 ± 0.035 at $\overline{T}$ = 653°K, in fair agreement with earlier experiments. Just as for helium and neon, a Lennard-Jones 12:6 potential model fails to account for the observed temperature variation of argon α_0 values. The best fit for an exp–six force model occurs for $\alpha = 17$ and $\epsilon/k = 176$°K. Using these force parameters, the best fit with experimental viscosity data yields $r_m = 3.535$ Å. The parameters were then used to calculate the diffusion coefficient and second virial coefficient for argon. There is fair agreement with the experimental values of the other transport coefficients. (auth)

3758 MASS SPECTRA AND METASTABLE TRANSITIONS OF H_2S, HDS, AND D_2S. Vernon H. Dibeler and H. M. Rosenstock (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 39: 3106-11(Dec. 1, 1963).

Mass spectra are reported for isotopic hydrogen sulfides. The occurrence of metastable transitions and the effect of isotopic substitution on their relative abundances are discussed. Appearance potentials are given for the molecule and fragment ions in H_2S, the molecule ions of HDS and D_2S, and the principal metastable transition in

each species. The latter process is interpreted as resulting from electronic transitions rather than from vibrational relaxation processes. (auth)

3759 SENSITIVITY OF EXCHANGE-REACTION PROBABILITIES TO THE POTENTIAL-ENERGY SURFACE. Frederick T. Wall and Richard N. Porter (Univ. of Illinois, Urbana). J. Chem. Phys., 39: 3112-17(Dec. 1, 1963).

Classical-mechanical calculations were made to study exchange attending collinear collisions of H + H_2 using a previously proposed potential-energy surface. It was found that the reaction probability is unity for all energies in a certain bounded range, and zero elsewhere. The lower and upper bounds are dependent upon the position of the saddle point of the potential-energy surface and the relative masses of the atoms. No long-lived collision complexes were encountered. The vibrational energies of the final molecules were also found to depend strongly upon the position of the saddle point. (auth)

3760 ABSORPTION AND EMISSION SPECTRUM OF $CaF_2:U^{3+}$ FROM 2.1 TO 2.5 MICRONS. Robert E. Meredith and Joe A. Jenney (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 39: 3127-30(Dec. 1, 1963).

The emission and absorption of $CaF_2:U^{3+}$ was scanned at 77 and 4.2°K and linewidths were measured. The spectrum is interpreted as arising from ions perturbed by a weak tetragonal crystal field. Preliminary results of the Zeeman effect on the narrowest lines are presented. (auth)

3761 ISOTOPE SHIFTS IN THE 2^1P AND 2^3P STATES OF THE He AND Li^+ SYSTEMS. Milos Machacek and Charles W. Scherr (Univ. of Texas, Austin). J. Chem. Phys., 39: 3151-2(Dec. 1, 1963).

Energy values and isotopic shifts were calculated for the 2^1P and 2^3P states of the He and Li^+ systems. The results were obtained by applying the variational procedure to 50-term wavefunctions. The discrepancy between theory and experiment was brought within the limits of experimental accuracy. (P.C.H.)

3762 ANNIHILATION RATES AND COLLISION COMPLEX OF POSITRONS IN FREON-12. J. H. Green and S. J. Tao (Univ. of New South Wales, Sydney). J. Chem. Phys., 39: 3160-1(Dec. 1, 1963).

Measurements were made of the lifetimes of positrons in Freon-12 at pressures from 1 to 5 atm, and the annihilation rate of positronium (longer lifetime component, τ_2) is represented by the formula $\lambda_2 = (6.76 + 0.56p) \pm 0.38 \times 10^6$ sec^{-1}. The annihilation rate at zero gas pressure was calculated to be $(6.76 \pm 0.38) \times 10^6$ sec^{-1}. (P.C.H.)

3763 ISOTOPIC EFFECTS IN GAS–LIQUID CHROMATOGRAPHY. I. GAS CHROMATOGRAPHIC BEHAVIOUR OF BENZENE AND PERDEUTEROBENZENE. Arnaldo Liberti, Gian Paolo Cartoni, and Fabrizio Bruner (Università, Naples). J. Chromatog., 12: 8-14(Sept. 1963).

The separation of benzene and perdeuterobenzene by gas–liquid chromatography was investigated on glass capillary columns. The nature of the liquid phase plays a very important role in the separation of isotopically substituted molecules, the less polar (squalane) being more effective than silicone oil. With the former, the separation is better than expected on account of the differences of vapor pressure, the reverse is found with the latter phase. The thermodynamics of the chromatographic process were studied, and the difference of ΔG, ΔH, and ΔS for both substances together with the ratio of the activity coefficients on squalane and silicone oil were calculated. (auth)

3764 ROTATION SPECTRA, QUADRUPOLE COUPLING, AND STRUCTURE OF VINYL BROMIDE. Robert E. Goedertier (Université, Louvain, Belg.). J. Phys., 24: 633-7(Aug. 1963). (In French)

The rotation spectra of 22 isotopic species of vinyl bromide are investigated between 13 and 25 Gc. Eight $^aR_{0,1}$ type transitions are observed between the levels having J = 1, 2, and 3. The dimensions are calculated. The trans H atom cannot be located with certainty. The quadrupole coupling exhibits an asymmetry $\eta = -0.08$ about the C–Br bond, which result is consistent with that of the other vinyl halides. (auth)

3765 OXIDATION OF URANIUM DIOXIDE BY AIR IN PRESENCE OF CARBONATES AND OXIDES. V. G. Vlasov and A. F. Bessonov (Kirov Urals Polytechnic Inst., USSR). Kinetika i Kataliz, 4: 666-71(Sept.-Oct. 1963). (In Russian)

Effects of alkali metal carbonate admixtures and ThO_2, ZrO_2, TiO_2, and U_3O_8 oxides on UO_2 oxidation rate by air were studied. All admixtures influence the oxidation process by altering crystal structure or by inducing or preventing new ion phases. The admixtures affect the UO_2 oxidation even when the oxidation process is limited by oxygen absorption. (R.V.J.)

3766 OXYGEN ISOTOPIC FRACTIONATION IN THE WATER OF CRYSTALLIZATION OF GYPSUM. R. Gonfiantini and J. C. Fontes (CNEN, Pisa, Italy). Nature, 200: 644-6(Nov. 16, 1963).

The oxygen isotopic composition of water samples was determined by equilibrating them with CO_2 at 25°C, and then analyzing the CO_2 with a mass spectrometer. Two sets of experiments that were used for the determination of the isotopic fractionation factor between water of crystallization of gypsum and water in which the deposition occurs are described. Isotopic results of the O^{18}/O^{16} ratio at 57 and 47°C are tabulated. (P.C.H.)

3767 FLUORESCENCE SPECTRUM OF DI-CAESIUM URANYL NITRATE. R. K. Asundi and R. M. Dixit (Atomic Energy Establishment, Trombay, India). Nature, 200: 668 (Nov. 16, 1963).

Di-cesium uranyl nitrate was prepared by mixing cesium nitrate and uranyl nitrate hexahydrate in an aqueous solution in the molar ratio of 2:1, or slightly higher, and evaporation at 10°C. The fluorescence spectrum of the di-cesium salt at 77°K consists of an extended system of bands. The structure of the spectrum is in general similar to that of the mono-cesium salt. Certain relevant relations between frequencies of the mono- and di-alkali salts are tabulated. (P.C.H.)

3768 NEW FLUORINE COMPOUNDS OF TECHNETIUM. A. J. Edwards, D. Hugill, and R. D. Peacock (Univ. of Birmingham, Eng.). Nature, 200: 672(Nov. 16, 1963).

Investigations indicated that the blue oxide tetrafluoride $TcOF_4$ (mp 134°C) and the yellow pentafluoride (mp 50°C) are formed as by-products in the direct fluorination of technetium metal. The oxide tetrafluoride is much like the rhenium analogue in appearance and in physical properties, and the magnetic moment (μ_{eff} (25°C) = 1.76 Bohr magnetons, θ = 9°C) is of the expected order for a d_1 compound. The pentafluoride is isostructural with chromium pentafluoride and has orthorhombic symmetry (a_0 = 7.6; b_0 = 5.8; c_0 = 16.6 A). It is more stable than rhenium pentafluoride, but begins to decompose in glass at 60°C. The reduction of technetium hexafluoride is also discussed. (P.C.H.)

3769 ON THE STUDY OF RADON REMOVAL WITH ACTIVE CARBON. Nobuo Fusamura (Waseda Univ., Japan), Shigenobu Ono, et al. Nippon Kogyo Kaishi, 79: 590-7(Aug. 1963). (In Japanese)

The saturated radon adsorption value As (μC/g) of active carbon is expressed as $As = 6.0 \times 10^3 \times (288/t)^{12.7} \times Cs$, where t is ambient temperature (°K) of the specimen and Cs is radon concentration (μC/cm) of air. The equation may be correct for temperature between 275 and 305°K. The value calculated with the equation agrees with BET adsorption isotherms. A practical device for radon removal was designed considering this result and tested in a closed gallery of a uranium mine. It is concluded that if a great deal of active carbon and silica gel are used, satisfactory radon removal is achieved. (auth)

3770 INVESTIGATION OF URANIUM OXIDES AND URANIUM CARBIDES BY DIFFERENTIAL THERMAL ANALYSIS. Reinhard von Ammon (Kernreaktor Bau- und Betriebs-GmbH, Karlsruhe, Ger.). Nukleonik, 5: 274-8 (Oct. 1963). (In German)

Investigations of some reactions of uranium oxides and uranium carbides by differential thermal analysis are described. The oxidation of UO_2 was found to proceed in two steps, which were strongly dependent on the temperature, particle size, and partial pressure of oxygen. The oxidation is combined with a strong surface growth. The reduction of U_3O_8 was found to occur in only one step, which showed scarcely any dependence on particle or surface size. The surface size decreases in the course of the reduction. The oxidation of UC was found to be a strongly exothermic process, which occurred at 350°C and by careful control yielded U_3O_8. U_3O_8 dissociated in about 1100°C oxygen to a complex, $UO_{2.25}(U_4O_9)$. The oxidation of a UO_2–Mo pellet led to a mixed phase, $MoO_3-U_3O_8$, which melts at about 1000°C. (tr-auth)

3771 LUMINESCENCE AND INTRACOMPLEX ENERGY TRANSFER OF URANYL PHTHALOCYANINE. G. N. Lyalin and G. I. Kobyshev. Opt. Spectry. (USSR) (English Transl.), 15: 135-9(Aug. 1963).

A study was made of the luminescence spectrum of a uranyl complex with phthalocyanine in dioxane and nonane solution. It was established from fine structure luminescence spectra, obtained by Shpol'skii's method, that the uranyl ion weakly perturbs the energy levels of the π-conjugated system of the asaporphyrine ring in the UO_2Phc molecule, where Phc is an abbreviated notation for the phthalocyanine skeleton. It was discovered that the luminescence of the complex compound has an abnormal temperature dependence. Participation of the coordination uranyl ion in the luminescence process was established. On the basis of the dependence of the luminescence spectrum on the wavelength of the exciting light it was concluded that two luminescent centers are present. One of them is the electronic transition from the excited singlet state to the normal (ground) state of the complex compound and the other is the luminescence during energy transfer from the uranyl cation to the system of π-conjugated bonds in the asaporphyrine ring. (auth)

3772 MAGNETIC PROPERTIES AND STRUCTURE OF YTTRIUM MANGANITE. E. F. Bertaut, R. Pauthenet, and M. Mercier (CEN, Grenoble, France). Phys. Letters, 7: 110-11(Nov. 1, 1963). (In French)

Two "triangular" models for the magnetic structure of $MnYO_3$, proposed to explain the neutron-diffraction data for this compound, are compared. A weak parasitic ferromagnetism that is observed allows a choice to be made between the two models. (T.F.H.)

3773 THE ATOMIC SPECTRUM OF NEODYMIUM. I. PRELIMINARY ANALYSIS AND IONIZATION POTENTIAL OF Nd I. G. E. M. A. Hassan (Universiteit, Amsterdam). Physica, 29: 1110-27(Oct. 1963).

The results of new wavelength measurements in the spectrum of neodymium are reported. The spectral region is 2201–2400 Å and in total 25,984 Nd-lines were observed. By means of the new list of wavenumbers 7 low even, 2 high even, and 20 odd levels are discovered. Of the low levels 6 belong to the new metastable configuration $4f^45d6s$. In the odd group, the configuration, $4f^35d6s^2$ is shown to be an important one. A complete re-interpretation is made for the odd levels known previously. The two levels of the high even group form a three term series with $4f^45d6s^7L_9$ from which the ionization potential of Nd I is found to be either 5.62 or 5.46 v, the ambiguity being connected with the identification of the series limit in Nd II. (auth)

3774 STUDIES OF ABNORMALLY MIXED CaF_2-CeF_3 AND CaF_2-YF_3 CRYSTALS IN CaF_2 MELTS. K. G. Myakishev and V. R. Klokman. Radiokhimiya, 5: 401-11(1963). (In Russian)

Abnormally mixed crystals formed in CaF_2-CeF_3-NaF and CaF_2-YF_3-NaF systems were studied. Cerium and yttrium fluorides precipitate with CaF_2 without a lower limit of miscibility. The absolute crystallization coefficient for CeF_3 is larger than for YF_3. Crystallization of CeF_3 and YF_3 is a function of temperature. With temperature increase of 151° (from 864 to 1015°) the magnitude D increased several times. Crystallization and solid-phase recrystallization time at constant temperature and melt composition differ from an ordinary equilibrium curve. Solubility of CeF_3 and YF_3 in the CaF_2-NaF system was determined at 864°C. (R.V.J.)

3775 COMPLEX FORMATION OF EUROPIUM WITH OXALATE ION BY ION EXCHANGE. A. S. Kereichuk and V. I. Paramonova. Radiokhimiya, 5: 464-73(1963). (In Russian)

Cation ion exchange studies of Eu complex formation with oxalate ion at an ionic strength of 0.5 and oxalate ion concentration 2×10^{-6} to 5×10^{-3} M revealed complex compounds $EuOx^+$, $EuOx_2^-$ and $EuOx_3^{3-}$. An analysis was made of the first $EuOx^+$ complex absorption on the stability constants $EuOx^+$, $EuOx_2^-$, and $EuOx_3^{3-}$. General stability constants of $EuOx^+$, $EuOx_2^-$, and $EuOx_3^{3-}$ were 6.4×10^4, 3.7×10^8, and 3×10^{11} respectively. An anion exchange method was employed to show that complexes $EuOx_3^{3-}$ and $EuOx_3^{3-}$ form in oxalate ion concentrations 0.06 to 0.3 M. (R.V.J.)

3776 VARIATIONS OF CHEMICAL POTENTIALS OF WATER IN $UO_2(NO_3)_2-M(NO_3)_n-H_2O$ TYPE SYSTEMS AT 25°C. M. A. Yakimov, N. F. Nosova, and V. K. Filippov. Radiokhimiya, 5: 474-9(1963). (In Russian)

Variations of chemical potential of water were determined in $UO_2(NO_3)_2-CsNO_3-H_2O$, $UO_2(NO_3)_2-TlNO_3-H_2O$, $UO_2(NO_3)_2-Zn(NO_3)_2-H_2O$, and $UO_2(NO_3)_2-Mg(NO_3)_2-H_2O$ systems at 25°C. An important role of anions in formation of a simple system was postulated and an identical behavior of zinc and magnesium nitrates as salting out agents was confirmed. (R.V.J.)

3777 SOLUBILITY OF HYDROCARBONS IN HEAVY WATER. A. N. Guseva and E. I. Parnov. Radiokhimiya, 5: 507-9(1963). (In Russian)

Solubility of n-heptane, cyclohexane, and toluene in H_2O and D_2O was investigated at 50 to 220°C. The solubility of hydrocarbons in H_2O is about 10% higher in D_2O. However, at higher temperature this tendency diminished. (R.V.J.)

3778 BAND SHIFT IN U(IV) ABSORPTION SPECTRA DURING FORMATION OF FLUORINE COMPLEXES. V. M. Vdovenko, G. A. Romanov, and V. A. Shcherbakov. Radiokhimiya, 5: 511-13(1963). (In Russian)

Absorption spectra of a solution with a constant concentration of U(IV) ions in 1 n $HClO_4$ and variable ratio $F^-:U^{4+}$ were measured at 20 ± 1°C using a SF-2M (400 to 750 mμ) spectrophotometer. The obtained data indicated that with increased fluorine ion concentration the absorption bands have a tendency to diminish and shift into the blue zone. (R.V.J.)

3779 TETRAGONAL ZIRCONIUM OXIDE PREPARED UNDER HIGH PRESSURE. F. W. Vahldiek, L. B. Robinson, and C. T. Lynch (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Science, 142: 1059-60(Nov. 22, 1963).

Tetragonal zirconium oxide, stable at room temperature, was synthesized at 15 to 20 kb and 1200 to 1700°C. Rapid quenching produced a mixture of the monoclinic and tetragonal phases. The high-pressure specimens, when heated to 1200°C in air and quenched, reverted to the all-monoclinic form. (auth)

3780 PHOSPHATE GLASS ELECTRODE WITH GOOD SELECTIVITY FOR ALKALINE-EARTH CATIONS. A. H. Truesdell and A. M. Pommer (Geological Survey, Washington, D. C.). Science, 142: 1292-4(Dec. 6, 1963).

A phosphate glass was found to have a significant electrode specificity toward alkaline-earth ions. The order of selectivity is $2H^+ > Ba^{2+} > Sr^{2+} > Ca^{2+} > 2K^+ > 2Na^+ > Mg^{2+}$. Exchange properties are discussed in relation to possible structure. Its use to determine activity of Ca^{2+} in natural systems containing Mg^{2+} is suggested. (auth)

3781 EVIDENCE FOR TETRAHEDRALLY CO-ORDINATED Co^{2+} IN BERYLLIUM FLUORIDE GLASSES. R. Pappalardo (Cyanamid European Research Inst., Geneva). Spectrochim. Acta, 19: 2093-7(Dec. 1963).

A comparison of optical absorption spectra of several systems containing Co^{2+} in different co-ordinations was used to infer that Co^{2+} is surrounded by a tetrahedron of fluorine ions in beryllium fluoride. (auth)

3782 PREPARATION AND PHYSICO-CHEMICAL PROPERTIES OF SCANDIUM NITRIDE. G. V. Samsonov, M. D. Lyutaya, and V. S. Neshpor (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Zh. Prikl. Khim., 36: 2108-15(Oct. 1963). (In Russian)

Chemical and physical properties and stability of scandium nitride ($ScN_{0.970}$) prepared by carbon in nitric acid reduction of scandium oxide at 1900 to 2000°C are described. Powdered scandium nitride proved to be unstable in water, acid, and alkali solutions while compact scandium nitride is stable only in sulfuric acid and non-concentrated alkali solutions. Nitride does not oxidize until 600°C after which the oxidation proceeds rapidly and is completed at 800°. Physical properties indicate the metallic character of $ScN_{0.970}$. (R.V.J.)

3783 PARAMAGNETIC RELAXATION OF RARE EARTH IONS IN LIQUID SOLUTIONS. M. M. Zaripov (Kazan Teacher's Inst., USSR). Zh. Strukt. Khim., 4: 674-81(Sept.-Oct. 1963). (In Russian)

Paramagnetic relaxation time in Ce^{3+} and Pr^{3+} liquid salt solutions was determined. The obtained values 10^{-13} to 10^{-14} sec were in good agreement with the relaxation mechanism but they were also related to the large width lines enabling determination of electron resonance by means of nuclear resonance. (R.V.J.)

3784 X RAY INVESTIGATION OF CERTAIN BINARY URANIUM AND VANADIUM OXIDES. Shih-hua Wang, L. M. Kovba, and V. I. Spitsyn. Zh. Strukt. Khim., 4: 714-18(Sept.-Oct. 1963). (In Russian)

Reactions between uranium and vanadium oxides were studied, and formation of UV_2O_6, UVO_5, and UV_3O_{10} were analyzed. The isostructure of UV_3O_6 was identical to $PbSb_2O$ with parameters of the hexagonal cell a = 4.986 ± 0.003, c = 4.755 ± 0.005 kX. The parameters for the rhombic nucleus UV_3O_{10} were a = 12.00 ± 0.01, b = 6.925 ± 0.005, and c = 16.9 ± 0.01 kX. A hexagonal subcell was separated from UV_3O_{10} and UVO_5 with U and V distributed at the subcell joints, with the alternating atoms forming a superstructure. Subcell parameters for UV_3O_{10} were a = 3.463, c = 4.05 kX and for UVO_5 a = 3.561 ± 0.002, c = 4.123 ± 0.01 kX. (R.V.J.)

3785 NUCLEAR MAGNETIC RESONANCE IN URANYL NITRATE CRYSTAL HYDRATES. N. M. Aleksandrova, V. M. Vdovenko, A. P. Sokolov, and V. A. Shcherbakov (Leningrad State Univ. and Khlopin Radium Inst., Academy of Sciences, USSR). Zh. Strukt. Khim., 4: 762-3(Sept.-Oct. 1963). (In Russian)

The position of water molecule protons in $UO_2(NO_3)_2 \cdot 6H_2O$, $UO_2(NO_3)_2 \cdot 3H_2O$, and $UO_2(NO_3)_2 \cdot 2H_2O$ was determined by nuclear magnetic resonance. (R.V.J.)

3786 TANTALUM AND COLUMBIUM CHEMICAL COMPOUNDS. H. Lamprey. p.598-618 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

The principal known compounds of Ta and Nb are the oxides and the salts of these oxides with various bases, the halides, and a few high-melting binary compounds formed with metalloids of small atomic radius such as B, C, Si, N, and P. These, together with a few others of miscellaneous nature, are discussed. Industrially, Ta and Nb compounds find relatively little use. Potassium fluotantalate, K_2TaF_7, is a commercial intermediate used in preparing Ta metal and also in preparing a catalyst for butadiene synthesis. Some tantalum oxide is used in making optical glass. Tantalum carbide, together with tungsten carbide and cobalt, serves in making carbide cutting tools and antiwear artifacts. Tantalum carbide tools are widely employed in machining operations. (auth)

3787 CARBON-14 ISOTOPE EFFECTS IN THE REACTION OF BENZYL BROMIDE AND OF p-NITROBENZYL BROMIDE WITH SILVER NITRITE. Ray Dean Taylor. Thesis, Stillwater, Okla., Oklahoma State Univ., 1962. 67p.

The isotope effects in Victor Meyer reactions were measured by synthesizing benzyl-α-C^{14} bromide and p-nitrobenzyl-α-C^{14} bromide and determining the isotope effects for the formation of each product as well as for the overall reactions. The two products appear to be formed by reactions of equal kinetic rate order since varying the effective concentrations of the reactants had no effect on the ratio of the isomeric products which were formed. The kinetic isotope effects in the formation of both of the isomeric products were found to be equal within the experimental accuracy of the measurements in both of the reactions studied. The over-all kinetic isotope effects for the two reactions were determined at 0° in diethyl ether. The results are fully consistent with the results that would be expected from a common transition state. (TCO)

3788 THE STRUCTURE OF THE ALKALI-EARTH METAL HEXAMMINES. Hans Joachin Holland. Thesis, Salt Lake City, Univ. of Utah, 1963. 64p.

Studies showed that clusters in alkali-earth metal hexammines are arranged in the solid about the body-centered cubic lattice with two molecules per unit cell. The metal atoms occupy the centers of ammonia octahedra and are situated at the corners and center of the unit cell. The

octahedra are oriented with their diagonals parallel to the edges of the unit cell. The cell edge increases with the atomic weight of the metal. A single-parameter analysis showed that the value of u is approximately 0.31. The nature of the samples necessitated the use of the powder method as well as low-temperature X-ray photography. Samples were prepared in Lindemann capillaries by condensing ammonia on a small sliver of the metal. Uncertainties in the internuclear distances can be attributed to slight variations in the metal-ammonia ratios, dark background of the film, and some line broadening. Although the space group of the alkali-earth metal hexammines can be narrowed to six possible choices, two lines of reasoning indicate that the correct choice is probably Im3m. If it is assumed that the ammonia molecule is rotating while inverting, cylindrical symmetry is obtained. An examination of the point symmetry shows that of the six possibilities, the highest symmetry for 12 ligands in general positions may be found in the space group Im3m. Calculations show that the energy needed to change face-centered calcium metal (Fm3m) to a body-centered lattice (Im3m) is of the order of one kcal per mole at –40°C. Hence, we may assume that in forming the hexammine from the metal and ammonia the above symmetry transformation takes place. The ease with which bonds in the alkali-earth metal hexammines are broken shows that ordinary valence forces are not involved. On the average, the valence electrons from the metal are probably closer to the metal than to the nitrogen. Hence, a dipole-induced dipole bond is expected. From the metallic properties of the alkali-earth metal hexammines and the structure determination, it was concluded that the compounds are very similar to the metals themselves. In the former, the metal-metal distance is greatly increased and the expanded-metal clusters replace the close-packed metal atoms themselves. (TCO)

3789 THE CHEMISTRY OF THE SOLVATED METAL CHELATES OF URANIUM(VI), THORIUM(IV), AND SCANDIUM(III) WITH 8-QUINOLINOL AND SUBSTITUTED 8-QUINOLINOLS. Guy Robert Horton. Thesis, Lubbock, Tex., Texas Technological Coll., 1963. 289p.

The nature of the interaction between the solvate molecules of scandium(III), thorium(IV), and uranium(IV) chelates with 8-quinolinol and 5,7-dihalo-8-quinolinols and the normal metal chelates were elucidated by dissociation pressure studies, x-ray diffraction analyses, infrared, ultraviolet, and visible absorption spectroscopy; and thermal stability studies. The heats of dissociation, ΔH, of the solvated chelates were determined by the Knudsen effusion method. From a knowledge of Kp for the dissociation reaction $M(Ox)_n \cdot HOx(s) \rightarrow M(Ox)_n(s) + HOx(g)$ the values for ΔH, ΔF, and ΔS were calculated. The heats of dissociation varied between 11.0 and 27.6 kcal. mole^{-1}, with the scandium chelates, generally having the smallest values and the uranium(VI) chelates having the largest. The chelates were also studied by x-ray diffraction analysis and the unit cell dimensions were calculated. The extra molecule of chelating agent caused the uranium(VI) chelates with 5,7-dihalo-8-quinolinols to be changed from triclinic to monoclinic symmetry. Just the opposite shift was observed for the 8-quinolinol chelate with uranium(VI). The complexes were investigated by infrared absorption spectroscopy, visible and ultraviolet absorption spectroscopy, high temperature reflectance spectroscopy, and the thermal properties were studied by thermogravimetric analysis and differential thermal analysis techniques. In almost every case, the results indicated that the uranium(VI) chelates were different in nature than the scandium(III) or thorium(IV) chelates. The formula proposed for the uranium(VI) chelates is $H[UO_2(Ox)_3]$ in which the uranyl ion has a coordination number of six. Similar structures for the thorium(IV) and scandium(III) chelates are unlikely in that coordination numbers of 8 and 10 would be presented for the scandium (III) and thorium(IV) ions, respectively. Therefore, the scandium(III) and thorium(IV) metal chelates with 8-quinolinol and substituted 8-quinolinols have different structures in the solid state than the uranium(VI) chelates. (TCO)

3790 TRI-n-OCTYLPHOSPHINE OXIDE AND TRIS(2-ETHYLHEXYL)PHOSPHINE OXIDE COMPLEXES OF URANYL NITRATE. Yeshwant Dwarkanath Soman. Thesis, Boston, Boston Univ., 1963. 144p.

The nature of the species resulting from uranyl nitrate-R_3PO (R = alkyl group) interaction was investigated. The two phosphine oxides selected for the study were: tri-n-octylphosphine oxide (TOPO) and tris(2-ethylhexyl)phosphine oxide (TEHPO). By extraction experiments, the solvation number of U(VI) by TOPO was found to be two. Extraction experiments also established that one U atom is present per formula unit of the complex. The result of the continuous variations experiment was consistent with a 1:2 stoichiometry for U(VI): TOPO. The effect of nitric acid on the extraction of U(VI) was investigated. Temperature dependence studies for the extraction of uranyl nitrate were carried out to arrive at approximate values of ΔH and ΔS. The complex was found to be highly stable. However, U-233 exchange experiments showed that the complex is labile. Precipitation of the uranyl nitrate-TOPO complex from ethanol by addition of excess water was studied quantitatively. This study together with the study of the infrared spectrum of the complex showed that the formula of the complex could be written as $UO_2(NO_3)_2(TOPO)_2$. The nitrate groups are coordinated to the central atom. The complex does not contain water. A decrease in the P—O absorption frequency by about 70 cm^{-1} was observed as a result of complex formation. Spectra in the visible light region showed absorption bands at 436 and 450 mμ for the complex. Cryoscopic molecular weight of the complex (prepared by reacting uranyl nitrate and TOPO in a 1:2 mole ratio in ethanol, followed by evaporation of the solvent) was found to be significantly different in the two solvents cyclohexane and benzene. A dipole moment value of about 8 Debyes was obtained for the complex. Concerning the nitric acid-TOPO interaction, a 1:1 stoichiometry was obtained at low $HNO_{3\,aq}$ concentrations. Sufficient evidence was obtained that in the case of uranyl nitrate-TEHPO a 1:2 complex is also formed. The uranyl nitrate-TEHPO complex could be precipitated like the corresponding TOPO complex. The TEHPO complex was found to be less stable compared to the TOPO complex. U-233 exchange studies established the lability of the U-TEHPO complex. A study of the infrared spectra showed that: the complex does not contain water; the P—O frequency is lowered by about 58 cm^{-1} on complex formation; and the nitrate groups in the complex are coordinated to the uranium atom. In the visible light region, absorption bands at 438 and 455 mμ were attributed to the complex. (TCO)

3791 AN EXPERIMENTAL STUDY OF THE ABSORPTION IN DISTILLED WATER, ARTIFICIAL SEA WATER AND HEAVY WATER IN THE VISIBLE REGION OF THE SPECTRUM. Seraphin A. Sullivan. Thesis, Washington, D. C., Catholic Univ. of America, 1962. 27p.

The absorption of light in various types of water was measured in the visible region to uncover bands representing the higher harmonics of the fundamental vibrational frequency. The absorption in distilled water and artificial sea water in the range 790-580 mμ, and in heavy water in the range 790-390 mμ was investigated with a high resolu-

tion spectrometer using a dense flint glass prism. The collimated beam from a steady tungsten source was chopped at 450 cps after passing through optical filters and the absorption cell. Cell lengths were 60.0 and 132.0 cm. The detector was a photomultiplier leading to a phase-comparator amplifier and a strip-chart recorder. Water triply-distilled over quartz was used. The artificial sea water was triply-distilled water to which chemicals were added to approximate particle-free sea water. The heavy water was 99.7% D_2O. All samples were filtered through ultrafine fritted-glass filters within three hours before testing. The absorption coefficient, α, is defined by the equation: $I = I_0e^{-\alpha x}$, where x is the path length, and I and I_0 are the intensities with the cell in and out of the path. Suitable corrections were made for the air-glass and glass-water surface reflections, since no reference cell was used. The mean of at least three observations for the absorption coefficient is reported at 2 and 1 mμ-intervals for all three types of water. Deviations from the mean are discussed and the results compared with previously published values. The absorption coefficients for the distilled and artificial sea water differ little from each other. Both show a strong absorption from 790–730 mμ, peaking at 745 ± 3 mμ, the same peak previously mentioned in the literature. Below 700 mμ, a step-like decrease in the absorption is evident, but no maximum was found, leading to the conclusion that the vibrational maxima below 745 mμ, are too weak to be observed. The heavy water shows very small absorption in the visible and no maximum. The absorption decreases gradually to a broad minimum in the region 700–600 mμ, then increases again gradually until at 390 mμ, it is a factor of ten greater than the minimum value. The spectrum for the heavy water indicated that a maximum might be found in the infrared as expected from the isotopic effect of the deuterium. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

3792 PARAMETRIZED SLATER MODIFIED HARTREE-FOCK METHOD APPLIED TO ACTINIDE IONS AND CRYSTAL FIELD SHIELDING IN Pr^{3+}. Carl John Lenander, III. Thesis, Los Angeles, Univ. of California, 1963. 88p.

A Slater Modified Hartree-Fock calculation was applied to several actinide ions. The coefficient of the Slater free electron exchange potential was treated as a parameter that is evaluated by matching a calculated 4f orbital of Pr^{3+} to a Hartree-Fock 4f orbital. A further comparison was made with the 3d orbital of Cu^+ to establish the constancy of the parameter. Both cases show good to excellent agreement in various radial matrix elements. The parametrized exchange potential was then applied to different configurations of the ions (16 in all) Th^{2+}, U^{4+}, Np^{4+}, Bk^{2+} and the trivalent ions from Pa^{3+} to Cf^{3+}. The appropriate orbitals were used to calculate the radial matrix elements (r^2), (r^4), (r^6), (r^{-3}), ζ, F^2, F^4 and F^6. A calculation of the shielding of the crystal field from the 4f electrons in Pr^{3+} due to the polarization of the outer $(5s)^2(5p)^6$ shell by the crystal field is also reported. The excited state wavefunctions necessary in this analysis were calculated and used to evaluate the appropriate matrix elements. The shielding effect is shown to be a principal constituent to the discrepancy of the experimental and theoretical values of the crystal field. (TCO)

3793 KINETICS OF THE REACTION OF ELEMENTAL FLUORINE WITH ZIRCONIUM CARBIDE AND ZIRCONIUM DIBORIDE AT HIGH TEMPERATURES. A. K. Kuriakose and J. L. Margrave (Univ. of Wisconsin, Madison). 16p. (CONF-184-2)

From Symposium on Inorganic Fluorine Chemistry, Argonne, Ill., Sept. 1963.

The reaction between ZrC and F_2 was investigated at 278 to 410°C, using 31 mm HgF_2. The reaction was found to be linear with time, and linear rate constants were computed. The activation energy was determined to be 22.1 ± 1.6 kcal/mole. ZrB_2 is not attacked by 31 mm HgF_2 below 500°C. The weight losses from reaction of ZrB_2 with F_2 at 600 to 900°C and of ZrC with F_2 at 700 to 950°C, were measured for a F_2 pressure of 2.7 mm Hg. Zero-time linear rate constants were calculated and found not to be strongly temperature-dependent above 600°C, and the activation energies are essentially zero for both ZrB_2 and ZrC. For ZrC at 350°C and for ZrB_2 at 700°C, the rate is approximately proportional to the square root of F_2 partial pressure, while for ZrC at 700°C, it is proportional to the 1.5 power of F_2 partial pressure. (D.L.C.)

3794 SURVEY OF THE SPECTRA OF THE DIVALENT RARE EARTH IONS IN CUBIC CRYSTALS. Donald S. McClure (Univ. of Chicago) and Zoltan J. Kiss. 26p. (CONF-68-6)

From The Electrochemical Society [Conference], Pittsburgh, Apr. 1963.

The rare earth ions may exist in the divalent state in suitable host crystals such as CaF_2. All of the trivalent ions from La to Yb are reduced in situ to the divalent state in CaF_2 by gamma irradiation. The spectra of most of these ions show that the ground and first few excited states derive from f^n configurations, but the weak absorption due to these is masked at higher energies by strong broad bands of the parity permitted $f^n \rightarrow f^{n-1}d$ transitions. The excitation energy of these spectra have been calculated in a first approximation as the energy difference between the "Hund Rule" single determinant states of the configurations $f^{n-1}d$ and f^n. This procedure satisfactorily accounts for the remarkable variations in the excitation energy in passing from one ion to the next in the series with the exception of Ge^{2+}, Ce^{2+}, and Tb^{2+}. Ge^{2+} probably has f^7d for its ground configuration, while Ce^{2+} and Tb^{2+} are borderline cases. The spectral structure probably arises chiefly from the crystal field splitting of the d-orbital, since each ion in CaF_2 has a similar spectrum, and the spectra change drastically in sites of other than cubic symmetry. (auth)

3795 THERMOCHEMICAL STUDY OF THE HOMONUCLEAR DIATOMIC MOLECULES AND OF SOME GASEOUS OXIDES OF SCANDIUM, YTTRIUM, AND LANTHANUM AND OF THE MOLECULE ScC_2. J. Drowart, G. Verhaegen, and S. Smoes (Universite Libre, Brussels). 16p. (CONF-74-24)

From 11th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

The following dissociation or atomization energies, in kcal/mole, were determined: $D_0^0(Sc_2) = 25.9 \pm 5$; $D_0^0(Y_2) = 37.3 \pm 5$; $D_0^0(La_2) = 57.6 \pm 5$; $D_0^0(YLa) = 47.3 \pm 5$; $D_0^0(ScO) = 158.8 \pm 5$; $D_0^0(ScC_2) = 290.0 \pm 5$; $D_0^0(Sc_2O) = 245 \pm 15$; $D_0^0(Y_2O) = 262 \pm 15$; $D_0^0(La_2O) = 265 \pm 15$; $D_0^0(Y_2O_2) = 460 \pm 20$; and $D_0^0(La_2O_2) = 475 \pm 20$. (auth)

3796 X-RAY MICRO-SPECTROSCOPY. A TABULAR PRESENTATION OF INSTRUMENTAL RESPONSES TO MICROGRAM QUANTITIES OF A SELECTED SERIES OF ELEMENTS. James C. Mathies and Paul K. Lund (Pacific Northwest Research Foundation, Seattle). 8p. (CONF-157-4)

From American Chemical Society Northwest Regional Meeting, Bellingham, Wash., June 1963.

Fluorescence yields for a series of elements using the gas-flow proportional detector, scintillation detector, and the universal detector are tabulated. (P.C.H.)

3797 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM METAL. Donald Duxbury and Ronald Robert Willan (to United Kingdom Atomic Energy Authority). British Patent 940,248. Oct. 30, 1963. Filed Apr. 25, 1961.

A process for the production of U metal by reduction of UF_4 using Mg or Ca is improved by the addition of a monofluoride of an alkali metal to the reactants. The additive should be from 0.25 to 2.5 wt % of the total weight of the reactants, with the preferred value being 1.25 wt % of sodium fluoride. The additive may be mixed with the UF_4 prior to mixing with the reductant, or it may be compacted into wafers and placed between compacted pellets of UF_4 and Mg or Ca. The use of sodium fluoride as an additive enables grades of UF_4 with as much as 3% of UO_2 impurities to be reduced with acceptable efficiency. (M.P.G.)

3798 PRODUCTION OF SCANDIUM AND YTTRIUM. Ronald C. Vickery (to Nuclear Corp. of America). U. S. Patent 3,111,467. Nov. 19, 1963. Filed June 3, 1960.

The production of high-purity scandium and yttrium is described with applications to an industrial production scale. Scandium or yttrium oxide is dissolved in the sodium double fluoride of the same metal and the resulting molten electrolyte is electrolytically decomposed and deposited in the form of pure metal. The pure metal is then mechanically separated from the remaining electrolyte. (R.E.U.)

Organic Chemistry

3799 DISTILLATION OF TERPHENYL MIXTURES BY MEANS OF A THIN-FILM EVAPORATOR. W. Haubold (Internationale Atomreaktorbau GmbH, Bensberg, Ger.). Atomkernenergie, 8: 343-5(Oct. 1963). (In German)

Based on experimental results, the suitability of the thin-film evaporator for continuous purification of organic coolants was evaluated. About 84% by weight of the high-boiler residues of terphenyl are distillable at 0.5 mm Hg and 350°C, a substantial portion of the hexaphenyls being volatile. (auth)

3800 C^{13} SPLITTINGS IN FLUORINE MAGNETIC RESONANCE SPECTRA. C. P. Van der Kelen (Rijksuniversiteit, Ghent). Bull. Soc. Chim. Belges, 72: 644-5 (Sept.-Oct. 1963).

Magnetic resonance spectra were recorded for two systems with fluorine bonded to an Sp^2 hybridized carbon atom: acetylfluoride and hexafluorobenzene. On both sides of the main fluorine resonance signal there were two weak incompletely resolved multiplets due to the C^{13} splitting. The separation of these centers was measured and taken as the spin-spin coupling constant $J_{C^{13}-F}$. The value found was 362 cps. (M.C.G.)

3801 METHANE–TRITIUM SYSTEM. I. MASS SPECTRA OF TRITIUM-SUBSTITUTED METHANES. Richard J. Kandel (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 39: 2581-7(Nov. 15, 1963). (LADC-5740)

The mass spectral pattern coefficients and sensitivities of the individual tritium-substituted methanes, CH_3T, CH_2T_2, CHT_3, and CT_4, were computed from the mass spectra of mixtures of tritium and methane that were undergoing isotopic exchange. Isotope effects in the ionization and dissociation of the various molecules were determined and compared with those observed in deuterium-substituted compounds. The following isotope parameters were found: for CH_3T, $\Gamma = 1.23$, $\pi = 0.62$; for CH_2T_2, $\Gamma = 1.53$, $\pi = 0.50$; for CHT_3, $\Gamma = 2.61$, $\pi = 0.57$; for CT_4, $\pi = 0.92$. (auth)

3802 THEORETICAL CONSIDERATIONS ON CARBON ISOTOPE EFFECTS IN THE DECARBOXYLATION OF MALONIC ACID. Marvin J. Stern (Brookhaven National Lab., Upton, N. Y. and Columbia Univ., New York) and Max Wolfsberg. J. Chem. Phys., 39: 2776-7(Nov. 15, 1963).

A model is presented for studying carbon isotope effects in the decarboxylation of malonic acid. Four rate constants are defined: $C^{12}H_2(C^{12}OOH)_2 \rightarrow C^{12}O_2(k_1)$; $C^{13}H_2(C^{12}OOH)_2 \rightarrow C^{12}O_2(k_2)$; $C^{12}H_2C^{13}-OOHC^{12}OOH \rightarrow C^{13}O_2(k_3)$; and $C^{12}H_2C^{13}OOHC^{12}OOH \rightarrow C^{12}O_2(k_4)$. Comparison of isotopic frequency shifts in reactants and transition states showed, in general, that changes occur over a large frequency range and are not localized. The isotope effect for the model discussed consists of two general terms corresponding to the zero-point energy contribution and to excitation of vibrations. Calculations with somewhat different force fields and transition state geometries (with $\nu_L^{\ddagger}$ always generated by setting the relevant $F_{CC}^{\ddagger} \leq 0$) led to differences in isotope effects that could be qualitatively rationalized within the 7 method. (P.C.H.)

3803 THE ADSORPTION OF ALKANES ON CRACKING CATALYSTS. I. A STUDY OF THE EXCHANGE BETWEEN ISOBUTANE AND ITS ADSORBED RADIOACTIVE ANALOGUE. John G. Larson and W. Keith Hall (Mellon Inst., Pittsburgh). 23p. (CONF-117-25)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Isobutane-C^{14} is chemisorbed on silica-alumina in three forms; two of these may be regenerated into the gas phase unchanged by exchange with non-radioactive i-C_4H_{10}; the third is irreversibly adsorbed and cannot be so regenerated. The exchange kinetics have been studied as a function of the pretreatment of the catalyst and of the evacuation temperature following contact with the radioactive gas. It has been found that the amount of the most loosely held form, V(1), can be reduced virtually to zero without altering the amount of the more strongly held chemisorbed forms by raising the evacuation temperature from 27 to 150°; further, V(1) is nearly independent of the manner in which the catalyst is pretreated. The more strongly held, exchangeable isobutane is unaffected by altering the evacuation temperature, but is quite sensitive to the pretreatment of the catalyst. The amount of this species, V(2), is greatly reduced by treating the catalyst with H_2 at elevated temperature, by base-exchanging it with KAc, or by adding-back H_2O, following the initial evacuation at 500°; it is increased by cooling the catalyst from 500° to room temperature in O_2 before evacuation. The non-exchangeable species, V(NE), responds similarly except that it is unaffected by base-exchange or by adding-back H_2O. As the rate constants per molecule for exchange (probability of desorption), k(i), are unaffected by these variables, the equilibrium adsorption-desorption rates, R(i), are proportional to the adsorbed amounts. Since R(2) is lowered by small amounts of added-back H_2O while the rate of exchange of i-C_4H_{10} hydrogen for catalyst deuterons is simultaneously increased, the enhanced rate of the latter reaction cannot be attributed to an increase in R(2) by a co-catalytic effect. Moreover, direct comparison of the rate of deuterium exchange, using i-C_4D_{10}, with R(2) reveals that the former rate is much too fast to be accounted for solely by the latter when H_2O has been added-back, whereas these same rates compare favorably when the catalyst is dry. It is concluded, therefore, that an additional process for H-exchange becomes important when H_2O has been added-back. (auth)

Radiation Chemistry and Radiochemistry

3804 (ASD-TDR-63-785) ELECTRON SPIN RESONANCE (ESR) STUDY OF GAMMA IRRADIATED SOLID ACETONITRILE. L. A. Harrah, R. E. Rondeau, S. Zakanycz, D. Hale, and D. Dunbar (Research and Technology Div. Air Force Materials Lab., Wright-Patterson AFB, Ohio). Aug. 1, 1963. 25p.

The solid phase cobalt-60 radiolysis of acetonitrile was investigated. Free radicals produced during the exposure to gamma rays were studied with an electron-spin resonance spectrometer and the final products were determined by gas chromatography and mass spectrometry. Predominant products are hydrogen, methane, and succinonitrile. The reaction paths to these products are inferred from, and consistent with, the ESR spectra of the trapped free radicals. (auth)

3805 (BMI-1654) RADIATION-INDUCED FORMATION OF ORGANOTIN COMPOUNDS. Robert E. Wyant, James L. McFarling, John F. Kircher, and E. Jack Kahler (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1963. Contract W-7405-eng-92. 13p.

Particle size of tin, ambient atmosphere, chemical structure of halide, irradiation temperature, pretreatment of tin, and additives were employed as variables in a study of the nature of the reaction between organic bromides and powdered tin in a radiation field. Temperature and tin pretreatment appeared to affect the yield to the greatest extent. Among the butyl bromide isomers the reactivity followed the order tertiary > secondary > primary. Under the best conditions found in these limited studies, i.e., temperature at 90°C and addition of hydrobromic acid to the halide, a G-value of ~600 was obtained using 1-bromobutane. (auth)

3806 (BNL-799(p.55-63)) RADIATION DIVISION. B. Manowitz (Brookhaven National Lab., Upton, N. Y.).

The radiolysis of mixed crystals of propionamide-acrylamide suggests energy from both propionamide and polymer to the unsaturated monomer. A study of the effect of temperature on toluene radiolysis indicates an activation energy of 0.4 kcal/mole for total gas, 1.7 kcal/mole for methane, and 0.2 kcal/mole for hydrogen. Sodium anthracene solutions are now being used to standardize the dielectric loss apparatus being developed to study ionic polymerization. Recent work suggests a high degree of ionic polymerization of styrene at room temperature when highly purified styrene monomer is irradiated with gammas. Work is continuing in the experimental determination of finite build-up factors, in gamma spectrum analysis, on the determination of self-absorption in radiation sources, and in the study of electrical discharge in shielding glass. Studies of the decontamination of high level waste supernates have continued. A series of exploratory runs was completed in which there was evidence of radio-induced copolymerization of ethylene with 18 out of 20 different monomers. Work on the chemonuclear program is continuing along the following lines: design and construction of the in-pile loop, development of fuel materials and forms, capsule studies of the effects of fission fragment bombardment of chemical systems, evaluation of chemonuclear reactors and processes, and the study of energy deposition by heavy particles. (N.W.R.)

3807 (BNL-7413) THE RADIOLYSIS AND PYROLYSIS OF SEVERAL POLYAROMATIC COMPOUNDS. J. Weiss, C. H. Collins, J. Sucher, and N. Carciello (Brookhaven National Lab., Upton, N. Y.) [1963]. Contract AT (30-2)-Gen-16. 53p. (CONF-14-43)

From American Chemical Society 144th National Meeting, Los Angeles, Mar. 1963.

The pyrolysis and radiolysis of several polyaromatic compounds which might be used as coolant material in a reactor were investigated using both gamma and reactor radiation. The compounds selected were naphthalene, anthracene, naphthacene, pyrene, phenanthrene, 1,2 benzanthracene, chrysene, triphenylene, 9,10 dihydrophenanthrene, phenazine, 7,8 benzoquinoline and m-phenanthroline, in addition to the uncondensed ring compounds, biphenyl, ortho, meta and para terphenyl and bibenzyl. Gas yields, percentage decomposition, percentage "high boiler" and number average molecular weights were determined. A correlation was found between radiation stability and electron affinity and singlet triplet excitation energies. The most stable compounds were the condensed ring compounds, naphthalene, pyrene, chrysene, phenanthrene and triphenylene. (auth)

3808 (CEA-2286) TRANSFORMATIONS CHIMIQUES ASSOCIEES A L'IRRADIATION NEUTRONIQUE DE L'ACIDE TELLURIQUE (THESES). (Chemical Transformations Associated with Neutronic Irradiation of Telluric Acid (thesis)). Michel Bertet (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1963. 80p.

Submitted to Paris Universite.

The chemical transformations which arise from irradiation of telluric acid with neutrons were studied under several experimental conditions. The effects of the reaction (n,γ) on Te^{IV} and of the isomeric transitions $^{131m}Te^{VI} \xrightarrow{\gamma} {}^{131}Te$ and $^{129m}Te^{VI} \xrightarrow{\gamma} {}^{129}Te$, and the oxidation states of ^{131}I formed by β decay of ^{131}Te were investigated in detail. The Szilard-Chalmers effect was put in evidence. Retention (R) depends on the isomeric state of Rd – Te and is higher for the metastable isotopes. R increases with the time of irradiation. R seems to be independent of the medium which is used for dissolving telluric acid irradiated in the solid state. Higher values of R are found if the acid is irradiated in neutral or alkaline solution; irradiation in acid solution leads to lower values for R. Retention for $^{131}Te^{VI}$ and $^{129}Te^{VI}$ formed by isomeric transition depends on the pH of the solution where this disintegration occurs. For instance, with ^{129}Te, R is greater in 6M NaOH (80 per cent) than in 3M HCl(40 per cent). The relative amounts of the oxidation states of I^{131} (reduced fraction (I^-, IO^-, I_2), iodate and periodate) depend on the medium, both if the acid is irradiated in the solid state and it is irradiated in solution. In the first case, the reduced fraction increases from 12 to 89 per cent when the dissolving medium is changed from neutral to 0.8M HNO_3. In the second case, the reduced fraction is 90 per cent in neutral or acid solution and 64 per cent in 0.5M KOH. It was shown, furthermore, that microamounts of Te^{IV} are formed in certain cases. (auth)

3809 (CONF-117-22) ELECTRON CAPTURE PROCESSES IN THE GAMMA RADIATION OF ORGANIC HALIDES IN HYDROCARBON RIGID MATRICES. E. P. Bertin and William H. Hamill (University of Notre Dame, Notre Dame, Ind.). [1963]. Contract [AT(11-1)-427]. 12p.

Relative electron capture cross sections of chloromethane derivatives were determined by competition with biphenyl anion in 3-methylpentane–2-methylpentene-1 mixtures, at liquid nitrogen temperatures. A species with λ_{max} at 680 mμ appears to be 2-methylpentene-1 cation. Irradiation of iodine, hydrogen, iodide, methyl iodide, n-butyl iodide, or p-diiodobenzene in 3-methylpentane produces species with λ_{max} = 770, 530, and 390 mμ. Methyl

iodide also has an absorption band at 430 mμ, due to a species of cationic character, probably CH_3I^+. The band at 390 mμ is assigned to I^-. In p-diiodobenzene, the solvent shows an 1800 mμ band, attributed to solvated electrons, which enhances the 390 mμ band upon selective illumination. Bromides yield analogous results. (auth)

3810 (JLI-2901-0-1) SPECIAL REPORT ON OZONE FORMATION IN THE RADIOLYSIS OF OXYGEN. (Johnston (William H.) Labs., Inc., Baltimore). Aug. 5, 1963. Contract AT(30-1)-2901. 64p.

Mechanisms of ozone formation in the radiolysis of pure oxygen are discussed. Overall chemistry, detailed mechanistics, and steady-state ozone formation are considered. It was concluded that linear energy transfer (LET) is the most important parameter determining the initial distribution of the various radicals, ions, and their excited states that are produced in the initial act. A calculation, neglecting the participation of excited states, gave a $G(O_3)$ range of 6 to 12, depending on LET. Including the excited states raised the $G(O_3)$ range to 10 to 18. It was established that ozone formation occurs by the reaction of oxygen atoms with molecular oxygen. (M.C.G.)

3811 (NP-13165(Vol.2)(p.133-42)) PREPARATION OF NEUTRON-DEFICIENT ISOTOPES OF HIGH SPECIFIC ACTIVITY RARE EARTHS OF CERIUM GROUP. A. K. Lavrukhina, G. M. Kolesov, and Hsiao-en T'ang (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Preparation of high-activity cerium-group rare earths without a carrier was previously achieved by high-energy proton bombardment of samarium and europium targets. It has been shown that the yield of neutron-deficient isotopes is 93% of the total and is 5 to 30 times higher than for Hf or Ta targets. Separation of Sm, Pm, and Ce was attempted by mercury-cathode electrolysis using current densities not exceeding 50 ma/cm^2 for 1.5 hr. Electrolysis using higher current densities for 30 min was also possible, but in both cases 3 to 5% Sm remained in the solution. Electrolysis with additions of potassium citrate resulted in efficient separations. The yield curves for chromotographic separations following electrolysis are given. (R.V.J.)

3812 (NP-13165(Vol.2)(p.143-9)) RADIOCHEMICAL SEPARATION OF IRIDIUM AND PLATINUM PRODUCTS BY SPALLATION OF GOLD BY 660 Mev PROTONS. A. K. Lavrukhina, B. A. Khotin, and T. V. Malysheva (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A method was developed for separating iridium and platinum from spallation products produced in 660-Mev proton bombardment of Au. The separation is based on anion exchange of chloride complexes. A diagram is given of distribution coefficients for various elements between an anion resin and HCl as a function of acid concentration. (R.V.J.)

3813 (NP-13332) RADIATION CHEMISTRY OF LIQUID PENTANE-, HEXANE- AND ISOPENTANE-IODINE 131 MIXTURES. J. H. Green and K. H. Napier (New South Wales, Australia. Univ., Kensington). [nd]. 28p.

Studies of the β and γ radiolysis of liquid pentane, isopentane, and hexane were made using the I_2^{131} scavenger technique. The formation of s-propyl and s-butyl iodides, experiments with relatively large concentrations of cyclohexene in the solutions, and recent mass-spectrometric data are discussed. (auth)

3814 (TID-18376) RADIATION CHEMISTRY STUDIES OF AQUEOUS IODINE-IODIDE SOLUTIONS. Cemil B. Senvar (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 7p. (UAC-7237)

The effect of pH on molecular product and free radical yields is reported for γ-ray irradiated air-free iodine–iodide solutions. Iodine scavenges hydrogen atoms and iodide ion scavenges hydroxyl radicals. As the pH increases in the range from 1 to 6, $G(H_2O_2)$ approaches $G(H_2)$ and the difference G(H)-G(OH) approaches zero. Values of G(H) and G(OH) found are compared with previous values. (auth)

3815 (TID-19761) EFFECT OF MERCAPTANS AND DISULFIDES ON PHOTOCHEMICAL AND HIGH-ENERGY RADIATION-INDUCED REACTIONS. Progress Report. Saul G. Cohen (Brandeis Univ., Waltham, Mass.). Dec. 1, 1963. Contract AT(30-1)-2499. 44p.

Inhibition by 2-mercaptomesitylene-mesityl disulfide of photoreduction of benzophenone by $(CH_3)_2CHOD$ leads to $(CH_3)_2CDOH$. Photoreduction in benzene of 0.5 M $(C_6H_5)_2C=O$ by $(C_6H_5)_2CHOH$, and of $C_6H_5COCH_3$ by $C_6H_5CH(OH)CH_3$, in which only 1 radical intermediate, $(C_6H_5)_2\dot{C}-OH$ and $C_6H_5\dot{C}(OH)CH_3$, respectively, is formed, are retarded by the S compounds in 10^{-3} to 10^{-2} M concentration. The single radical is oxidized to its ketone by disulfide, reduced to carbinol by mercaptan according to the equation $C_6H_5COCH_3 + ASH + AS\cdot \xleftarrow{ASSA} C_6H_5\dot{C}(OH)CH_3 \xrightarrow{ASH} C_6H_5CH(OH)CH_3$. Mercaptan and disulfide show equal effectiveness, being each converted to the same mixture of the two during the irradiation. Retardation by the mercaptan-disulfide of reduction of $C_6H_5COCH_3$ in optically active $C_6H_5CH(OH)CH_3$ leads to racemization, and retardation in $C_6H_5CH(OD)CH_3$ leads to $C_6H_5CD(OH)CH_3$. The S compounds show increasing effectiveness in retarding reduction: $(C_6H_5)_2C=O$, $(C_6H_5)CHOH < C_6H_5COCH_3$, $C_6H_5CH(OH)CH_3 < (C_6H_5)_2C=O$, $(CH_3)_2CHOH < C_6H_5COCH_3$, $(CH_3)_2CHOH$, 9×10^{-3} M, 6×10^{-3} M, 1.2×10^{-3} M and 1×10^{-3} M thiyl group halving the rates of reduction, respectively. Study of rates and quantum yields as functions of concentration of the carbinol and concentration of naphthalene quencher leads to: $k_{db} \cong 2\times10^5$ sec^{-1} for decay of triplet of acetophenone; and of $4-6\times10^5$ 1 mole^{-1} sec^{-1} for abstraction of H from 2-propanol by triplet acetophenone k_{1d}; from α-methylbenzyl alcohol by triplet acetophenone k_{1b}; and from 2-propanol by triplet benzophenone, k_1. Study of rates as functions of concentration of the S compounds leads to: $k_{5b} \cong 1\times10^4$ 1 mole^{-1} sec^{-1} for transfer of H from 2-mercaptomesitylene to acetophenone-ketyl radical; $k_{5e} \cong 0.5\times10^4$ 1 mole^{-1} sec^{-1} for transfer of H from benzyl mercaptan to acetophenone-ketyl radical; $k_{5a} \cong 0.5\times10^4$ 1 mole^{-1} sec^{-1} for transfer of H from 2-mercaptomesitylene to benzophenone-ketyl radical. Photoreduction of acetophenone in the presence of alkoxide led to its pinacol, unlike that of benzophenone, which led to benzhydrol. (auth)

3816 (TID-19770) CHEMICAL EFFECTS OF IONIZING RADIATION ON INDIVIDUAL AMINO ACIDS WITHIN THE INTACT AND PURE PROTEIN MOLECULES. Felix Friedberg (Howard Univ., Washington, D. C.). [1963]. Contract AT(30-1)-2735. 6p.

Results are described briefly for the studies of (1) the effects of gamma radiation on the amino acid content and the enzymatic activity of ATP-creatine phosphotransferase, (2) the transformation of amino acids by gamma irradiation in polyamino acids and peptides, and (3) radiation effects on hydrogen bonding in ribonuclease. Studies in progress are also described. (D.L.C.)

3817 (AEC-tr-4579) RADIOCHEMISTRY. Translation of Radiokhimiya, 3: Nos. 1-2, 1961. 272p.

3818 (UCRL-Trans-996(L)) REVERSIBLE CHANGES OF pH SOLUTIONS OF CERTAIN ORGANIC SUBSTANCES DURING EXPOSURE. A. P. Terent'ev. Translated by Sergey Shewchuck (California. Univ., Livermore. Lawrence Radiation Lab.) from Dokl. Akad. Nauk SSSR, 68: 537-9(1949). 6p. (Includes original, 3p.).

A qualitative study was made on the instantaneous effects of ultraviolet light on the pH of aqueous solutions of a large number of organic acids, nitrous bases, and alcohols and other oxy compounds. Experiments on water and HCl solutions showed that ultraviolet had no effect on their pH. For most of the organic acids, the pH is increased by 0.1 to 0.3 unit, the increase being especially high for the oxy acids. Only tartaric and fumaric acids show a pH decrease; benzoic, sulfanilic, and benzenesulfonic acids are not affected. Similarly, for most of the nitrous bases, alcohols, and oxy compounds, pH is increased by 0.2 to 0.4 unit on exposure to ultraviolet. Only pyridine, phenol, and dioxane are not affected. (D.L.C.)

3819 ELECTRON PARAMAGNETIC ABSORPTION IN γ-IRRADIATED POLYCRYSTALLINE $Hg_2(NO_3)_2 \cdot 2H_2O$. I. Bőjko (Inst. of Physical Chemistry, Polish Academy of Sciences, Wroclaw). Acta Phys. Polon., 24: 281-2(Aug. 1963).

Investigation of electron paramagnetic absorption in mercurous nitrate irradiated with γ rays from Co^{60} was carried out with a device operating at 9400 MHz. Subsequent to irradiation, three absorption lines of equal amplitude appeared. The average separation between adjacent lines was 58 Gauss. The space-averaged g = 2.00. At about -15°C, the spectrum underwent distortion. At +60°C, the absorption signal was found to vanish suddenly. All three lines vanish at the same rate and the absorption spectrum at room temperature always presents an amplitude ratio of 1:1:1. From the experimental results it can be concluded that one is dealing with hyperfine structure of the spectrum deriving from interaction between the electrons and nuclear magnetic moments of spin I = 1. (C.E.S.)

3820 NUCLEAR RADIATION-INDUCED CRACKING OF n-HEXADECANE. Edwin O. Guernsey, Henry Shaw, and William E. Smith (Socony Mobil Oil Co., Princeton, N. J.). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 9: 744-50 (Nov. 1963).

A representative paraffin hydrocarbon in the gas oil range, n-hexadecane, was irradiated. In the vapor phase radioinduced cracking proceeded efficiently, and G values for radiation conversion of n-hexadecane were 200 to 1200 at temperatures near 750°F. Total conversions of n-hexadecane were less than 3 wt % and were due only in part to the radiation effect. The distributions of products that were obtained were similar to those that result from thermal cracking of n-hexadecane. There were however significant increases in the yields of hydrogen, reductions in the yields of very light hydrocarbons, and small yields of high molecular weight products. At temperatures above 850°F extensive thermal cracking obscured the effects of radiation. In liquid phase radioinduced cracking at 750°F conversions of n-hexadecane up to 15 wt % were obtained at liquid spaces velocities near 4 v/hr/v. In many exposures nearly one-half of the conversion was attributed to the direct utilization of radiation. The corresponding G values were 30 to 60. The products obtained were accounted for by adding together the products that would be expected from a radioinduced reaction producing primarily dimer, from radioinitiated chain propagated cracking, and thermally initiated chain cracking. The product distribution from these reactions can be changed by variation of the cracking temperature and/or radiation dose. (auth)

3821 RADIOLYSIS OF REDUCED DIPHOSPHOPYRIDINE NUCLEOTIDE IN AQUEOUS SOLUTION. S. J. Adelstein and Lorna K. Mee (Cambridge Univ., Eng.). Biochemistry, 2: 1294-7(Nov.-Dec. 1963).

The radiolysis of DPNH solutions by 250-kvp x rays has been followed utilizing the absorption at 340 mμ, the corresponding fluorescence at 470 mμ, and the coenzymatic activity with alcohol dehydrogenase. All three parameters are decreased simultaneously and this reduction in DPNH concentration is neither linear nor logarithmic with dose. The coenzyme is protected in the presence of protein; the protection afforded by glutamic dehydrogenase, a DPNH-binding enzyme, is equal to that of serum albumin at the same weight concentration. The radiolysis of DPNH is independent of pH over the range 4.8–7.5 and is accompanied by an initial increase in pH, 260-mμ absorption, and cyanide reactivity. These observations suggest that DPNH is the first product formed which is, in turn, degraded logarithmically. A kinetic model for the radiolysis was formulated which gives a G(-DPNH) of 2.3 in air and 1.2 in oxygen-free nitrogen. (auth)

3822 LOOP NO. 2 FOR IRRADIATION OF PETROLEUM FRACTIONS. M. Massan (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 121-5 (Aug.-Sept. 1963). (In French)

A loop designed and built in accordance with the Euratom-CEA contract concerning the Orgel project is described. The loop allows studies on radiolysis and pyrolysis of various organic products likely to be used as cooling fluids in nuclear reactors. The irradiation temperature can reach 450°C, the pressure 40 kg/cm^2, and the flow rate 2 m^3/hour; heating is supplied by electrical resistances located on the out-of-pile circuit and by a thermo-plunger in the liquid. Previous tests were carried out on terphenyl OM2. (auth)

3823 TERPHENYL LOOP FOR RADIOLYSIS ANALYSES. F. Franzetti and A. Houllier. Bull. Inform. Sci. Tech. (Paris), No. 75, 127-31(Aug.-Sept. 1963). (In French)

A loop was designed to study the radiolysis of terphenyl OM2. The composition of this commercial terphenyl is: biphenyl, <1%; ortho phenyl, 15 to 25%; meta phenyl, 70 to 80%; para phenyl, <5%; and heavy residue, 0%. Its crystallisation point is lower than 80°C. The out-of-pile part is made of stainless steel and designed to work at 450°C and 40 kg/cm^2. The principal parts of the loop are: a pump (capacity 8 m^3/h); a control flow valve actuated by a flowmeter; a degasser; and filters. An auxiliary circuit is equipped with a viscosity meter. The pressurization of the loop, the degassing, and the sample taking of liquids and gases are done in auxiliary circuits. The in-pile part is designed for 450°C and 25 kg/cm^{-2} and is thermally isolated by a container under vacuum. This in-pile part contains a heater (maximum output 100 w/cm^2); if the heater is switched off the liquid flows without a temperature gradient in the loop. (auth)

3824 EFFECT OF AN ELECTRIC FIELD ON THE SCINTILLATIONS PRODUCED IN A GAS BY α PARTICLES. Jean-Louis Teyssier, Daniel Blanc, and Alain Godeau (Faculté des Sciences, Toulouse). Compt. Rend., 257: 2458-9(Oct. 21, 1963). (In French)

The reenforcing effect of an electric field on the scintillation of Xe, Ar, and He was studied. The intensity of the fluorescence increases linearly as a function of E/p.

At the same time the energy resolution is improved. This method is utilized to show scintillations in air. (tr-auth)

3825 THE ACTION OF ULTRAVIOLET LIGHT ON FREE RADICALS FORMED IN γ-IRRADIATED POLYPROPYLENE. V. K. Milinchuk and S. Ya. Pshezhetskii (Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 665-7(Sept. 21, 1963). (In Russian)

The irradiation of transparent sheets of polypropylene with Co^{60} at a dose rate of ~500 rads/sec at 77°K leads to the formation of alkyl radicals (1), $-CH_2-C^*(CH_3)-CH_2-$, which show a superfine structure of 8 lines in the EPR (electron paramagnetic resonance) spectrum. Subsequent irradiation with unfiltered ultraviolet light at 77°K has no effect on the concentration of alkyl radicals (1). Allyl radicals (2), $CH_2-C^*(CH_3)-CH=C(CH_3)-CH_2-$, were detected at room temperature in polypropylene. The EPR spectrum shows a superfine structure of 9 lines at 77°K, and of 17 lines at room temperature. Allyl radicals (2) are converted to alkyl radicals (1) at 77°K by adsorbing short wavelength ultraviolet light (λ = 1800 to 2000 Å) because of the excited state of the radical and migration of atomic hydrogen. The same reaction is also observed at 313°K after heating the irradiated polypropylene for a period of 5 to 10 minutes. The total number of radicals remains constant. The reaction is much slower at liquid nitrogen temperatures. It was also found that the allyl form of the peroxide radical is converted to an alkyl peroxy radical containing a hydroxide group. (TTT)

3826 THE RADIOLYSIS OF PIPERIDINE AS INVESTIGATED BY ELECTRON PARAMAGNETIC RESONANCE (EPR). A. A. Revina and A. P. Podsoblyaev (Inst. of Electrochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 668-70(Sept. 21, 1963). (In Russian)

Sealed samples of piperidine were irradiated with γ rays at 77°K at a dose rate of 5.2×10^{16} ev/g-sec in vacuum and in the presence of oxygen. The concentration of radicals was a linear function of dose from 5×10^{19} to 1×10^{21} ev/g for the vacuum irradiation with a radiation yield of G = 5.5 radicals/100 ev. Only a poorly resolved doublet with a splitting of ~40 oersteds was observed, and the structure of the EPR spectrum did not vary. The concentration of radicals decreased with increasing temperature, but no conversion of one radical into another could be detected. It is postulated that $C_5H_{10}NH^+$ radicals are formed by the following reaction: $C_5H_{10}NH \rightsquigarrow C_5H_{10}NH^+ + e^-$. The electrons are trapped in the solid. Tetrahydropyridine and H_2 are formed by neutralization of the $C_5H_{10}NH^+$ radical by the thermalized electron, which is freed by increasing the temperature: $C_5H_{10}NH^+ + e^- \rightarrow C_5H_{10}NH \rightarrow C_5H_9N + H_2$. Since the EPR spectra are the same in vacuum and in the presence of oxygen, it can be inferred that peroxide radicals are not formed during irradiation in the presence of oxygen, or on subsequent heating of the irradiated sample up to its melting point. (TTT)

3827 DIFFUSION KINETICS OF FREE RADICALS IN RADIATION CHEMISTRY. Li-hwei Wang. Hua Hseuh Tung Pao, No. 5, 12-18(1963). (In Chinese)

The diffusion-kinetics method of studying free radicals, applied to radiation chemistry reactions, involves the use of homogeneous reaction kinetics for the treatment of radiation reactions taking place within ion groups. Two types of free-radical models are used for describing diffusion kinetics in water and in aqueous solutions. A single free-radical model describes the case in which a low-voltage beam is directed at the solution. The ion groups created are kept far from each other and thus each ion group can be considered as an isolated system, following diffusion processes according to Fick's law, or the recombination reaction of 2 free radicals. On the basis of this model, the effect of various beams on the ionization rate of water can be demonstrated. The double free-radical model is used when several isotopes are present in the system. According to this model, the 2 types of free radicals formed when water is ionized, require individual treatment. The chief problem is the determination of the constants needed for solving the kinetic equations. (TTT)

3828 THE CONCEPT OF ISOTOPES AND THE DISPLACEMENT LAW. Wei-chuen Li. Hua Hseuh Tung Pao, No. 5, 35-7(1963). (In Chinese)

The basic concepts of isotopes are reviewed in order to develop the displacement law. Practical examples are presented for the use of the displacement law in radiation chemistry. The theoretical considerations used show that ionium is derived from uranium-II. The same concept is used to prove the existence of radium C' (Po^{214}). (TTT)

3829 SYNTHESIS OF THE SULFUR-35-LABELED POTASSIUM ETHYL AND n-BUTYL XANTHATE. Son-lin Wu. Hua Hseuh Tung Pao, No. 5, 58(1963). (In Chinese)

The method used for the preparation of ethyl and n-butyl xanthate, labeled with S^{35}, is reviewed. The process, which uses acetone as solvent, yielded satisfactory results and may be employed at the microchemical level. The S is added in the form of CS_2^{35}. The final product is collected in form of a precipitate, the excess alcohol is removed in vacuum, and the material is dried by an infrared lamp in vacuum. (TTT)

3830 MODIFICATION OF HISTIDINE BY ULTRAVIOLET IRRADIATION OF LYSOZYME. Umberto Ferrini and Romano Zito (Istituto Regina Elena for Cancer Research, Rome). J. Biol. Chem., 238: PC3824-5(Nov. 1963).

Native and ultraviolet-irradiated tryptophan were completely hydrolyzed by proteolytic enzymes and the end products compared. Results indicated that, while tryptophan remained essentially unchanged, the histidine content decreased markedly during irradiation. A close correlation was found between histidine loss and enzyme inactivation in lysozyme exposed to ultraviolet radiation. (C.H.)

3831 PHOTOINDUCED CHANGE OF ORGANIC FREE RADICALS AS STUDIED BY ESR. I. CONVERSION OF ALLYL-TYPE TO ALKYL-TYPE RADICALS IN IRRADIATED POLYETHYLENE. Shun-ichi Ohnishi, Shun-ichi Sugimoto, and Isamu Nitta (Japanese Assn. for Radiation Research on Polymers, Osaka). J. Chem. Phys., 39: 2647-53(Nov. 15, 1963).

The allyl-type radical $-CH_2-\dot{C}H-CH=CH-CH_2-$ in irradiated polyethylene was converted into the alkyl-type radical $-CH_2-\dot{C}H-CH_2-$ upon uv illumination (λ 2537 Å). During the conversion total concentration of the radicals remained constant. The production curve of the alkyl-type radical reached a saturation at 43% conversion. Initial rate of production of the alkyl-type radical was found proportional to the light intensity, while the saturation concentration was the same for illuminations of different intensities. The initial rate was independent of the illumination temperature and of presence of added hydrogen gas. A reaction mechanism which involves an intramolecular hydrogen atom shift was put forward:

$$-CH_2-CH_2-\dot{C}H-CH=CH-\underset{k_2}{\overset{k_1}{\rightleftharpoons}}-CH_2-\dot{C}H-CH_2-CH=CH-.$$

The corresponding kinetic equation was solved and the rate constants k_1 and k_2 as well as the quantum yield were cal-

culated from experimental results. It was found that this mechanism would explain all the features of the reaction satisfactorily. In addition to conversion to the alkyl-type radical, minor reaction of the allyl-type radical also took place simultaneously to produce polyenyl radicals of shorter length, evolving hydrogen gas. The ESR results were consistent with the evidences obtained from uv-visible spectra. (auth)

3832 INTERPRETATION OF HOT-ATOM DATA. Chi-hua Hsiung and Adon A. Gordus (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 39: 2770-1(Nov. 15, 1963).

The main effects that appear to determine the yields of gas-phase hot-atom chemical reactions are discussed. Special attention is given to previously determined data on the yields of DT, CH_3T, and HT in a mixture of D_2 and CH_4 with 3-mole % O_2 scavenger. (P.C.H.)

3833 ESR STUDY OF FREE RADICALS PRODUCED IN IRRADIATED CYCLOPENTADIENE AND CYCLOHEXENE: THE CYCLOPENTADIENYL AND CYCLOHEXENYL RADICALS. Shun-ichi Ohnishi and Isamu Nitta (Japanese Assn. for Radiation Research on Polymers, Osaka). J. Chem. Phys., 39: 2848-9(Dec. 1, 1963).

The ESR spectra of irradiated cyclopentadiene and cyclohexene were measured at various temperatures. The spectra showed motional narrowing on raising temperature and the free radicals were identified from analysis of the narrowed spectra. Cyclopentadiene showed a well-resolved sextet spectrum of 5.6-G splitting, which was assigned to the cyclopentadienyl radical. Cyclohexene gave a spectrum consisting at least of 26 lines, which can be reasonably attributed to the cyclohexenyl radical by assuming appropriate hyperfine constants. (auth)

3834 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED GLASSES CONTAINING BORON. Sook Lee and P. J. Bray (Brown Univ., Providence). J. Chem. Phys., 39: 2863-73(Dec. 1, 1963).

Electron spin resonance (ESR) spectra were observed for various types of alkali borate and borosilicate glasses that were exposed to γ or thermal neutron irradiations. The irradiated alkali borate glasses ($Li_2O-B_2O_3$, $Na_2O-B_2O_3$, $K_2O-B_2O_3$, $Rb_2O-B_2O_3$, and $Cs_2O-B_2O_3$) containing less than 25 mole % alkali oxide exhibit spectra consisting of five peaks in the resonance absorption curve at an operating microwave frequency in the vicinity of 9.2 kMc/sec. The same five-line resonance was also observed in the irradiated borosilicate glasses (Corning 7070, 7740, and 7720). Investigations of the irradiated glasses by means of a K-band ESR spectrometer operating at approximately 23.3 kMc/sec yielded spectra that are partially resolved into six lines. Alkali borate glasses isotopically enriched with B^{10} display a 10-line resonance at the X-band frequency when irradiated with γ rays or neutrons. It was concluded that the five- and six-line resonances arise from an axially symmetric hyperfine interaction of a hole with a B^{11} nucleus, while the 10-line structure arises from such a hyperfine interaction with a B^{10} nucleus. The atom containing this B^{11} or B^{10} nucleus is believed to be in a BO_4 tetrahedral configuration in the glass structure. (auth)

3835 KINETIC THEORY OF HOT-ATOM REACTIONS. II. EVALUATION OF COLLISIONAL ENERGY LOSS. APPLICATION TO REACTIVE MIXTURES. Richard Wolfgang (Yale Univ., New Haven). J. Chem. Phys., 39: 2983-93 (Dec. 1, 1963).

The kinetic theory of reactions of atoms of high translational energy undergoing moderating collisions was further developed. The nature and validity of the assumptions underlying the treatment and the range of applicability of the final expressions are discussed in detail. It is shown that experimental data on the total probability of reaction in which the hot atom is chemically bound can be used to evaluate two fundamental quantities: the reactivity integral, or reaction probability integrated over energy on a logarithmic scale (I); and a measure of average energy transfer in collisions of hot atoms with the reactive species (α). The treatment involves no variable or arbitrary parameters. As a result sufficient data may be obtained to provide stringent internal consistency tests of the applicability of the model and its assumptions to any given system. Two types of systems are specifically treated: a single reactant moderated by inert gas; and competitive reactions in systems of two reactants. The relative utility of such systems for determination of the basic parameters α and I is discussed. Examples of the use of the expressions developed to calculate average logarithmic collisional energy loss (α) are given. Recent data on interaction of hot F with CF_4 and on hot H in mixtures of D_2 and CH_4 are used. The α's derived indicate that moderating collisions in these media are highly inelastic. The hypothesis that CH_4 is a better moderator than D_2 was quantitatively confirmed. The implications of the findings for the mechanism of hot-atom processes are briefly discussed. (auth)

3836 APPLICATION OF AN ELECTRON CAPTURE DETECTOR TO CHEMISTRY OF RADIATIONS. J. P. Adloff and P. Gueguenіat (Centre de Recherches Nucléaires, Strasbourg). J. Chromatog., 12: 96-8(Sept. 1963). (In French)

An electron capture detector for use in radiation chemistry is described. The detector is used in connection with gas chromatography for the determination of free radicals in mixtures of organic iodides present in very weak concentrations in a hydrocarbon. It consists of an ionization chamber containing a radioactive source of tritium and is particularly sensitive to organic iodides. The detector does away with some disadvantages of the previous method using iodine-131. (P.C.H.)

3837 TOTAL QUANTUM FLUX OF ISOTROPIC SOURCES. J. Woodland Hastings and Gregorio Weber (Univ. of Illinois, Urbana and Sheffield Univ., Eng.). J. Opt. Soc. Am., 53: 1410-15(Dec. 1963).

The total radiant flux from a solution containing a radioactive compound, hexadecane-1-C_{14}, plus an appropriate scintillator was determined. The procedure used involves comparison of its luminescent emission with the light scattered by glycogen illuminated with a monochromatic homogeneous light beam of known photon flux. From the result obtained the scintillation quantum yield of a β^- disintegration from carbon-14 was determined to be 793 photons; thus 5.25% of the energy appears as light. (auth)

3838 RADIOINDUCED OXIDATION OF HEPTENE-1. V. V. Saraeva and Yu-t'ai Chin (Moscow State Univ.). Kinetika i Kataliz, 4: 662-5(Sept.-Oct. 1963). (In Russian)

Chain reactions induced by molecular oxygen radiation oxidation of heptene-1 begin at 8°C forming peroxides and carbonyl compounds. Effective activation energy of heptene-1 products are lower than for n-heptane (3.8 ± 0.5 and 6.0 ± 1.0 kcal/mole, respectively. A considerably higher oxidation yield was observed with radiation oxidation of n-heptane–heptene-1 mixture, moreover the highest sensitization action took place with heptane concentration below 10 mole %. The sensitization effect is related with heptane energy transfer to heptene-1. (R.V.J.)

3839 ON RADICALS PRODUCED BY LOW-TEMPERATURE TOLUENE RADIOLYSIS. N. Ya. Buben, V. A.

Tolkachev, and I. I. Chkheidze (Inst. of Chemical Physics, Academy of Sciences, USSR). Kinetika i Kataliz, 4: 683-7 (Sept.-Oct. 1963). (In Russian)

Spectra of electron paramagnetic resonance radicals formed by fast electron irradiation of frozen $C_6H_5CH_3$ and $C_6D_5CH_3$ are correlated with previously developed spectra for phenyl, benzyl, and cyclohexadiene radicals. It is shown that hydrogen atoms initially broken off of the CH_3 group and phenyl ring react differently with the admixtures and form cyclohexadiene radicals while the first radicals having higher kinetic energy are spent during the second process in which the second hydrogen atom breaks off from the toluene molecule. (R.V.J.)

3840 STUDY OF THE RADIATION EFFECTS ON CANCEROGENIC AND NON-CANCEROGENIC AZO- DYE-STUFFS. W. Damerau. Monatsber. Deut. Akad. Wiss. Berlin, 5: 507-11(1963).

Cancerogenic aromatic carbohydrogens, which differ in their electron structure from chemically similar non-cancerogenic molecules, were studied. The effects of x radiation were investigated by means of paramagnetic electron resonance and no relationship between such radiation and cancerogenic activity was detected. (OTS)

3841 FORMATION OF PEROXIDIC PRECIPITATE IN THE RADIOLYSIS OF URANYL NITRATE KETONE SOLUTIONS. Jiří Teplý and Václav Štulík (Czechoslovak Academy of Sciences, Prague). Nature, 200: 671-2 (Nov. 16, 1963).

A yellow insoluble substance was formed in the gamma radiolysis of moist uranyl nitrate–methyl isobutyl ketone solutions saturated with oxygen at a dose rate of 0.6×10^{16} to 4.0×10^{16} ev/ml. The yellow substance, which remains clinging to the walls of the irradiation vessel, was identified as $UO_4 \cdot 4H_2O$ by weight analysis. In the concentration range of 0.001–0.1 M $UO_2(NO_3)_2 \cdot 6H_2O$ the initial yield G(U) = 2.7. At concentrations of 0.001 and 0.01 M the precipitate formation is stopped at corresponding doses as a consequence of the exhaustion of uranium from the solution. At higher concentrations than 0.1 M the yield G(U) is smaller and an induction period appears. At concentrations above 0.1 M the precipitate is no longer formed. The influence of nitric acid was evident. (P.C.H.)

3842 I^{131}-POLYVINYLPYRROLIDONE. H. R. von Gunten, R. Haeberli, and H. Huegli (Institut für Reaktorforschung, Würenlingen, Switzerland). Nucl. Med., 3: 299-311(1963). (In German)

The preparation and iodination of an I^{131}-labeled polyvinylpyrrolidone suitable for diagnostic uses is described. After purification and fractionation a highly stable product with less than 1% of free I was prepared. Molecular weights were kept within desired limits and 50% of the I^{131} used for labeling was incorporated in the product. The purity of the iodinated PVP was checked by paper chromatography, and molecular weights were determined by viscometry and osmometry. Some factors influencing the stability of the iodinated PVP such as purity, temperature, pH, oxygen, and radiation were investigated. A hypothesis for the structure of iodinated PVP is given. The iodinated PVP is probably a 4-iodo-polyvinyl-pyrrolidone. (auth)

3843 SOME PROBLEMS OF CHEMONUCLEAR TECHNOLOGY. II. CHEMONUCLEAR PROCESSES. Anatol Selecki and Jan Bulanda (Inst. of Nuclear Research, Warsaw). Przemysł Chem., 42: 279-82(June 1963). (In Polish)

The general engineering and economical problems of chemonuclear processes are reviewed. The processes discussed include, in particular, the synthesis of the various oxides of nitrogen, and preparation of hydrazine, ethylene glycol and phenol, representing cases with the greatest possibility for successful fabrication on an industrial scale. The items reviewed include cost estimates for the specific cases, the factors governing the yield per unit of the absorbed radiation dose and decontamination of the finished product. The problems of the low-temperature cracking and polymerization methods are also presented, together with a listing of the currently existing chemonuclear installations. (34 references). (TTT)

3844 EFFECTS OF α IRRADIATION OF METHYLENE BLUE IN SULFURIC ACID. M. V. Vladimirova and Z. V. Ershova. Radiokhimiya, 5: 479-85(1963). (In Russian)

Studies of methylene blue decolorization by α irradiation from dissolved polonium indicated that decolorization is a function of absorbed energy. A complete acceptance of radicals in the solution takes place with methylene blue 5×10^{-5} m concentration with the yield of reverse decolorization at 0.8 n sulfuric acid equal to 0.35 molecule/ev corresponding to atomic yield of H 0.7 molecule/100 ev. The yield of OH radicals in 0.8 n sulfuric acid is equal to 0.6 molecule/100 ev. The initial water decomposition in α radiolysis is equal to 4.4 molecule/100 ev. (R.V.J.)

3845 REACTIONS OF TRITIUM RECOIL ATOMS WITH CYCLOPENTANE–CYCLOHEXANE SYSTEMS. E. N. Avdonina and A. N. Nesmeyanov. Radiokhimiya, 5: 514(1963). (In Russian)

Gas-liquid chromatographic analysis was made of tritium recoil reactions in cyclopentane–cyclohexane mixture. A diagram of radiochemical yield showed that the activity of pure component gas fractions was three times higher than that of the original component and remained practically constant for the whole concentration range. Radiochemical yield of original compounds was found to be a linear function of concentration. (R.V.J.)

3846 REACTIONS OF HOT TRITIUM ATOMS WITH ALIPHATIC ALCOHOL IN LIQUID PHASE. A. N. Nesmeyanov, Tai-wang Chiang, and E. S. Filatov. Radiokhimiya, 5: 515-16(1963). (In Russian)

Hot tritium atom reactions with aliphatic alcohols (20 μl alcohol and 20 μg Li_2CO_3) irradiated in a reactor by thermal neutron flux of 5×10^{11} neutron/cm^2 sec for 4 hr at 50°C, 2.0×10^{12} neutron/cm^2 sec for 5 hr at 150°C, and 0.87×10^{13} neutron/cm^2 sec for 15 and 30 min at 50°C were investigated. The results showed that neither the flux density, integral flux nor temperature influence the distribution nor yield of labeled products. Tabulated data are given on the yield of tritium-labeled products formed in $Li_2CO_3^+$ alcohol mixtures at the above conditions. (R.V.J.)

3847 RECOIL EFFECT IN Co^{60} FOLLOWING (γ,n) REACTION IN COMPLEX COBALT COMPOUNDS. A. N. Nesmeyanov and V. Mudrova-Yablonitska. Radiokhimiya, 5: 516-19(1963). (In Russian)

Effects of thermal annealing on Co(III) glycinate and complex compound Co(III)–vitamin B_{12} following (γ,n) and (n,γ) reactions were estimated. Four first order processes were found for Co(III) triglycinates; the Co(III)–vitamin B_{12} specimen was not affected by the thermal treatment. The results are similar to Co^{60} recoil atom stabilization in (n,γ) reaction and confirm the Amar Nath et al. (Radiokhimiya, 5: 1, 125(1963)) hypothesis on formation of defect centers during the last stages of recoil atom cooling. (R.V.J.)

3848 CERTAIN PECULIARITIES OF Zr^{95} BEHAVIOR IN SOLUTIONS WITHOUT CARRIER. L. N. Pankratova, L. G. Vlasov, and A. V. Lapitskaya. Radiokhimiya, 5: 519-20(1963). (In Russian)

An analysis of depressed adsorptive property of Zr^{95} after prolonged contact with glass wool showed that the contact with glass wool converts a certain part of zirconium into non-ionic form. (R.V.J.)

3849 PREPARATION OF $UX_1(Th^{234})$ WITHOUT A CARRIER BY EXTRACTION METHOD. Yu. A. Afanas'ev and A. I. Ryabinin. Radiokhimiya, 5: 520-1(1963). (In Russian)

Separation of Th^{234} without a carrier from uranyl nitrate solution by extraction of U by 5% tributylphosphate is described. Tabulated data of 20 experiments showing UX_1 distribution between the aqueous and organic phases following 4 to 5 extractions are included. (R.V.J.)

3850 OZONE FORMATION IN AIR EXPOSED TO COBALT-60 GAMMA RADIATION. Z. I. Kertesz and Grace F. Parsons (New York State Agricultural Experiment Station, Geneva). Science, 142: 1289-90(Dec. 6, 1963).

The amount of ozone formed in air exposed to a 4000-C cobalt-60 radiation source was determined. In closed glass containers exposed to about 1 Mrad of gamma radiation, ozone concentrations up to 18 parts per million (by volume) were recorded. In air flowing through a glass structure placed near the source, ozone contents up to 0.1 ppm were observed. It is suggested that ozone formation might be a factor in the reported germicidal effects of ionizing radiations and that damage to plant tissues, ascribed to radiation, might have resulted from exposure to ozone. The possible health hazards from the ozone produced during irradiation should not be overlooked. (auth)

3851 PRODUCTION OF Ar^{38}, Kr^{80}, Kr^{82}, AND Xe^{128} TRACERS BY THE NEUTRON IRRADIATION IN JRR-2. Kaoru Taniguchi (Japan Atomic Energy Research Inst., Tokyo), Jun Okano, et al. Shitsuryo Bunseki, 10: No. 21, 113-19(Oct. 1962). (In Japanese)

Preliminary experiments were carried out in order to produce Xe^{128}, Kr^{80}, Kr^{82}, and Ar^{38} tracers from potassium iodide, ammonium bromide, and sodium chloride by the neutron irradiation in the JRR-2 reactor. Samples were irradiated under a thermal neutron flux of $4.3 \times 10^{12}/cm^2$-sec for 20 minutes. Gamma rays from irradiated samples were analyzed, and the existence of Br^{82}, I^{128}, and Na^{24} was confirmed. After two months of irradiation, 0.1-g samples were heated at 1000°C in a vacuum to extract the rare gas products. The extracted gas samples were analyzed with a mass spectrometer and the quantities of Xe^{128}, Kr^{80}, Kr^{82}, and Ar^{38} were roughly estimated to be 6×10^{-7}, 4×10^{-7}, 1×10^{-7}, and 8×10^{-7} cc, respectively. Using Xe^{128} gas, produced in this way, spikes of 10^{-9} cc were prepared in order to measure the micro-amount of Xe^{130} (double β decay product). The method for the preparation of the spikes is described. (auth)

3852 INVESTIGATIONS OF THE STABILITY OF IODIZED, WATER-SOLUBLE X-RAY CONTRAST MEDIA UNDER THE INFLUENCE OF VISIBLE LIGHT, ULTRAVIOLET, AND RADIOACTIVE RADIATION. Richard Schuessler (Universität des Saarlandes, Homburg/Saar, Ger.). Strahlentherapie, 122: 311-19(Oct. 1963). (In German)

Experimental studies concerning the stability of iodized and water-soluble x-ray contrast media (concerning the iodine binding) are reported. The contrast media Abrodil, Per-Abrodil, Urografin, and Biligrafin were exposed to visible light, ultraviolet irradiation, and radiation from I^{131}. All contrast media investigated separate iodine from the molecule under these influences. Using aromatic compounds (Per-Abrodil, Urografin, Biligrafin) the separated I appears as iodide in solution. At concentrations under 10% elementary I also appears. Using the aliphatic substance (Abrodil) the separated I appears mainly as elementary I. Observing simple precautionary measures (light-tight storage of the contrast media, especially the diluted solutions, and low specific activity in labeled substances), no measurable separation of I from the molecule appears. A source of errors, caused by the radiolysis which appears during handling of labeled substances is pointed out. (auth)

3853 ELECTRON SPIN RESONANCE STUDY OF X-IRRADIATED LYSINE MONOHYDROCHLORIDE DIHYDRATE. Yu. D. Tsvetkov, R. J. Cook, J. R. Rowlands, and D. H. Whiffen (Inst. of Chemical Kinetics and Combustion, Academy of Science, Novosibersk, USSR and National Physical Lab., Teddington, Eng.). Trans. Faraday Soc., 59: 2213-17(Oct. 1963).

X irradiation of l-lysine monohydrochloride dihydrate yields two radicals. The abundant species is shown to be the radical $H_3N^+(CH_2)_4\dot{C}H(CO_2^-)$. Insufficient experimental data were available to make a complete analysis of the minor species, but it is probably the radical $NH_3^+CH_2CH_2\dot{C}HCH_2CH(NH_3^+Cl^-)CO_2^-$. (auth)

3854 RADIATION CHEMISTRY OF NITRIC OXIDE SOLUTIONS. W. A. Seddon and H. C. Sutton (Edinburgh Univ.). Trans. Faraday Soc., 59: 2323-33(Oct. 1963).

The chemical effects induced by small doses of Co^{60} γ rays on aqueous solutions of nitric oxide are expressed by the reactions: $H_2O + 4NO \rightarrow 2HNO_2 + N_2O$ and $2H_2O \rightarrow H_2 + H_2O_2$. At pH 4.5 the product yields are $G(HNO_2) = 6.1$, $G(N_2O) = 3.2$, $G(H_2O_2) = 0.55$ and $G(H_2) = 0.38$, while $G(-NO) = 12.3$ molecules per 100 ev. A reaction mechanism involving the intermediaries $e^-_{aq.}$, H, OH, and HNO is proposed to account for these observations. From studies of the retarding influence of nitrite ion on the reaction it is inferred that the rate constant ratio equals approximately 4.7, and hence that O_2 and NO react at equal rates with $e^-_{aq.}$. N_2O has a relatively small influence on the reaction, which suggests that N_2O reacts slowly with $e^-_{aq.}$. Studies of other systems led to a contrary conclusion and reasons for this apparent discrepancy are suggested. (auth)

3855 ROLE OF UNSATURATION IN THE RADIATION CHEMISTRY OF POLYMERS. PART I. POLYETHYLENE. M. A. Crook and B. J. Lyons (British Insulated Callender's Cables Ltd., London). Trans. Faraday Soc., 59: 2334-49 (Oct. 1963).

A study was made of the variation in concentration of the forms of carbon-carbon unsaturated groups initially present in a low and a high density polyethylene with ionizing radiation dose, and the effect of added allyl and vinyl unsaturation as triallyl cyanurate, 1,19-eicosadiene, and divinyl benzene. The expressions for decay of unsaturated groups, which were proposed by previous workers, are not obeyed although the observed deviations from these relations may be slight. The results are interpreted in terms of a mechanism that postulates energy migration to, or localization in the vicinity of, unsaturated groups followed, in most cases, by a chain reaction involving radicals. The characteristics of trans-vinylene growth in polyethylene may be explained by postulating that radiolytically formed trans-vinylene groups do not enter into a chain reaction but scavenge radicals. (auth)

3856 ROLE OF UNSATURATION IN THE RADIATION CHEMISTRY OF POLYMERS. PART 2. GEL FORMATION IN POLYMER AND TRIALLYL CYANURATE MIXTURES. P. E. Cross and B. J. Lyons (British Insulated Callender's Cables Ltd., London). Trans. Faraday Soc., 59: 2350-4(Oct. 1963).

The gelling doses of polyethylene, polymethyl acrylate, and polyvinyl acetate are significantly decreased by small additions of triallyl cyanurate (TAC). Though larger additions of TAC inhibit gel formation at low doses, at higher doses gel formation is considerably increased. An estimate of the cross-linking efficiency of TAC in polyethylene leads to the conclusion that at concentrations between 0.5 and 5.0%, each additive molecule cross-links to between 2.5 and 3 polymer molecules, indicating that reactions such as hydrogenation or polymerization of the allyl groups are insignificant in this concentration range. (auth)

3857 CHEMICAL EFFECTS OF RADIATIVE THERMAL NEUTRON CAPTURE. PART 13. INFLUENCE OF CRYSTAL DEFECTS. T. Andersen and A. G. Maddock. Trans. Faraday Soc., 59: 2362-8(Oct. 1963).

Further evidence is presented that the thermal and radiation annealing processes are closely related to defects in the crystal lattice. Experiments with Ca-, La-, and Tl-contaminated material indicate that the relevant defects are lattice vacancies. (auth)

3858 RADIOCHEMICAL STUDIES OF CHEMISORPTION AND CATALYSIS. PART 6. ISOTOPE EFFECTS IN THE DISPLACEMENT OF TRITIUM AND HYDROGEN FROM NICKEL FILMS BY MERCURY. G. K. L. Cranstoun and S. J. Thomson (Univ. of Glasgow). Trans. Faraday Soc., 59: 2403-14(Oct. 1963).

Tritiated hydrogen was adsorbed on nickel films at 25°C, and then progressively displaced by mercury. The specific activities of small samples of displaced gas were determined. During the first 10% of the process the ratio of the probabilities for hydrogen displacement to tritium displacement was 1:3. This ratio became 1:2 for the remaining 90% of the displacement. About 11-14% of the hydrogen and 25% of the tritium could not be displaced by mercury. When films were sintered, or only partially saturated with tritiated hydrogen, or partially precovered with oxygen, the specific activities of the displaced samples were lower than in the previous case. The ratio for hydrogen to tritium displacement by mercury was 1:3. Retention of hydrogen and tritium was higher at about 20 and 40% respectively. When films were partially covered with H_2 and then with H_2 + HT molecules, or vice versa, there was evidence that the films were heterogeneous: the last isotope adsorbed tended to be richer in the first samples displaced, and vice versa. (auth)

3859 EFFECTS OF ^{60}Co γ-RAY ON VITAMINS. II. ON CRYSTAL AND AQUEOUS SOLUTION OF RIBOFLAVIN. Tomoo Takahashi and Etuko Yamamoto (Shionogi and Co., Ltd., Japan). Yakugaku Zasshi, 83: 487-91(May 1963). (In Japanese)

Comparison of γ-ray decomposition and photodecomposition of aqueous solutions of riboflavin under four conditions showed differences in their ultraviolet spectra and paper chromatographic changes. In γ-ray decomposition, lumichrome is not formed, differing from the case of photodecomposition in neutral and acid reactions. It was also found that a substance not found after photodecomposition is formed by γ-ray decomposition. The substance shows up as a fluorescent spot on paper chromatograms. (auth)

3860 THE RADIOLYSIS OF THE ALKALI AND ALKALINE EARTH PERCHLORATES. Louis Arthur Prince. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1963. 268p.

An investigation of the radiolysis of the alkali and alkaline earth perchlorates was undertaken to determine the effect of gamma rays on anhydrous perchlorate crystals. A systematic study of perchlorates was considered to be of particular interest because of their important chemical properties. Studies were made on: the analysis of the radiolytic decomposition products, and any changes in yields of these products that may occur in the course of irradiation; the mechanisms of formation of the products; the effect of variations in temperature, pressure, and radiation intensity on product formation; and any correlations between product formation and the properties of the various perchlorates, including thermodynamic properties, physical properties, or between radiolytic and thermal decomposition products. The radiolysis of nine anhydrous alkali and alkaline earth perchlorates, $LiClO_4$, $NaClO_4$, $KClO_4$, $RbClO_4$, $CsClO_4$, $Mg(ClO_4)_2$, $Sr(ClO_4)_2$, $Ba(ClO_4)_2$, and $Ca(ClO_4)_2$, by Co-60 gamma rays was effected to several percent decomposition. Products of decomposition that were definitely identified in irradiated crystals or in their aqueous solutions are Cl^-, ClO^-, ClO_2^-, ClO_2, ClO_3^-, and C_2. Quantitative methods of analysis for each product were developed. G_0 yields were determined for all products and for ClO_4^-. A stoichiometric agreement was found between calculated yields of O_2 liberated into the crystal lattice on product formation and experimental yields. The identified products were found present as initial radiolytic products in all nine perchlorates irradiated at room temperature with one exception, ClO_2^- was not detected in samples of $Ca(ClO_4)_2$ of absorbed dosage below 5×10^{21} ev/g but was identified as a decomposition product at higher dosage. It is shown that ClO_4^- decompositions for all nine perchlorates are approximately first order order, and that, with the exception of ClO_2, the radiolytic yields of the products of decomposition are linear with dose over at least a short dosage range. Generally, on increased absorbed dose, yields of ClO_3^-, O_2, ClO_2^-, ClO^-, and ClO_2 decrease, with rates varying from slow to rapid respectively. Decrease in yields of ClO_2^-, ClO^-, and ClO_2 are attributed to combined radiolytic and thermal decomposition. Decrease in yields of ClO_3^- are attributed to combined ClO_4^- depletion and radiolytic decomposition, and also with some perchlorates to back reaction of the type $ClO_3^- + O \rightarrow ClO_4^-$. Chloride yields of all perchlorates increase at higher absorbed doses, and this is attributed largely to combined radiolytic and thermal decomposition of the products $ClO^- + ClO_2^- + ClO_2$ to produce $Cl^- + O_2$, to radiolytic decomposition of ClO_3^-, and in some instances to increases in yields directly from ClO_4^-. Exceptions to these generalities are: $LiClO_4$, and $Sr(ClO_4)_2$ show increased yields of ClO_3^- and O_2 after a small absorbed dose of about 0.4×10^{21} ev/g; $Ba(ClO_4)_2$ also shows an increase in ClO_3^- yields beyond an absorbed dose of about 0.4×10^{21} ev/g; $Sr(ClO_4)_2$ does not show a significant decrease in ClO^- and ClO_2^- yields on increased absorbed dose; O_2 yields drop sharply at certain absorbed doses, which vary with the different perchlorates, and this is shown to result from crystal rupture and escape of oxygen from the lattice. The observed weight loss following crystal rupture is shown to be a linear function of dose. The investigation has revealed that in the radiation decomposition process of the perchlorates, both the free space in the perchlorate lattices, or, more precisely, the crystal forces that determine free space, and for which free space is but a manifestation, and the thermal stability of the products, are major factors in determining preferred paths of decomposition. (TCO)

3861 IZMERENIE I IDENTIFIKATSIYA BETA-RADIOAKTIVNYKH PREPARATOV. (Measurements and Identification of Beta Radioactive Preparations). V. B. Luk'yanov. Moscow, Gosatomizdat, 1963. 168p.

Measurement and identification of β-active preparations are reviewed. Beta emission and half life are discussed, and physical identification and recording of β emitters are evaluated. (R.V.J.)

3862 TRITIUM β-DECAY INDUCED ISOTOPIC EXCHANGE WITH WATER VAPOR. J. Y. Yang, C. Smith, and L. H. Gevantman. 20p. (CONF-117-19)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Tritium β-decay induced isotopic exchange between tritium gas and water vapor was investigated. The exchange rate is found essentially constant within a four fold increase in water vapor density, but it varies as a second order function of the tritium concentration. With helium as an inert moderating gas for the absorption of β-energy and tritium concentration in the range of 0.05 to 0.7 curie per liter, the reaction rate in mc/l/day at room temperature may be approximated by $[d(HTO)/dt] = 3.6 \times 10^{-5} (T_2)^2$, where (T_2) is the initial tritium concentration expressed in mc/l. The use of a number of inert gases as moderators gave results indicating important roles involving inert gas sensitized energy transfer. Nitric oxide as additive in the reaction mixture exerted a strong inhibiting effect on the formation of tritiated water. A reaction mechanism consistent with these observations is proposed. (auth)

3863 THE EFFECTS OF GAMMA-RADIATION ON THE ELECTRONIC PROPERTIES OF NAPHTHALENE. Paul A. Andrews (Controls for Radiation, Inc., Cambridge, Mass.); Alton F. Armington, and Bernard Rubin. 10p. (CONF-117-18)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Electrical evaluations were carried out on irradiated naphthalene. From the results it can be stated that the radiolysis of naphthalene produces a spectrum of, primarily, saturated hydrocarbons ranging from hydrogen through ethane and on to longer-chained paraffin-like compounds. In addition, some "polymer" forms of naphthalene, which could not be detected by the previously mentioned analytical tools, must be formed. This hypothesis is necessary to account for the hydrogen atoms used in the formation of the paraffin compounds. The formation of the "polymer" is also suspected because prolonged vacuum sublimation of the irradiated material leaves a residue which is spongy and rubbery. Because of its limited solubility in a suitable solvent, no infrared data was taken of this substance. The change in the electronic properties of naphthalene can be postulated as follows: For conduction to take place through a polycrystalline pellet, the charge carrier must move from one crystallite to another. If, however, the periphery of the crystallites has been altered by radiation in such a way that radiation products are less conductive than the original material, then more energy is required to cause conduction. It appears probably that this is what is occurring with the irradiated naphthalene. In other words, contact between unaltered naphthalene crystallites in the compressed pellet is lessened by the formation of saturated paraffin-like compounds whose conductivities are less than that of naphthalene. Undoubtably, the polymer form of naphthalene would probably be more conductive and have a lesser apparent energy gap value than naphthalene, but it is quite possible that saturated hydrocarbon chains are chemically attached to the periphery of the polymer molecules and essentially act as poor mediums for charge carrier conduction. These hypotheses would account for the increase in resistivity and apparent energy gap. (auth)

3864 ON THE IRRADIATION OF POLYETHYLENE CRYSTALS. Ronald Salovey and David C. Bassett (Bell Telephone Labs., Inc., Murray Hill, N. J.). 5p. (CONF-117-24)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The irradiation behavior of solution crystallized linear polyethylene (Marlex 50) was found to exhibit marked differences depending on preparative conditions. For very thick films contact was impaired and gel formation suppressed. However, in a thin film contact was good, so that no hindrance was introduced to intercrystal crosslinking and infinite network formation. The importance of fold surface packing was demonstrated. (P.C.H.)

3865 IMPROVEMENTS RELATING TO GOLF BALLS. Walter Cecil Davey, Stanley Richard Harrison, and Albert Edward Toney Neale (to Dunlop Rubber Co. Ltd.). British Patent 938,364. Oct. 2, 1963. Filed Mar. 9, 1959.

Radiation can be used in vulcanization of a synthetic trans-polymer of a conjugated diene containing up to 6 carbon atoms in the molecule for use as golf-ball covers. The radiation dose required is usually in the neighborhood of 1×10^7 to 5×10^7 rads. Tests indicated the superiority of this type of cover. (M.C.G.)

3866 POLYMERIZATION BY GAMMA RAYS AND NOVEL PRODUCTS PRODUCED THEREBY. Michel A. Jobard (to Compagnie de Saint-Gobain). Canadian Patent 661,673. Apr. 23, 1963. Priority date Feb. 3, 1955, France.

A method is described for preparing pure homogeneous polymers with superior properties. The method comprises irradiating a pure liquid monomer and filtering the polymer from the monomer. The method is limited to the production of polymers which are insoluble in the monomers, e.g., vinyl chloride, vinylidine chloride, acrylic nitrile, and halogenated ethylenes. An apparatus for carrying out the method is described. Examples of the method are given using vinyl chloride, acrylic nitrile, and chlorofluoroethylene. (D.L.C.)

3867 RADIATION POLYMERIZATION PROCESS AND PRODUCTS THEREOF. Raymond Lanthier (to Shawinigan Chemicals Ltd.). Canadian Patent 663,529. May 21, 1963. Filed Aug. 3, 1960.

A process is given for producing very high molecular weight polyvinyl acetate which on alcoholysis forms very high viscosity polyvinyl alcohol. The process comprises emulsifying vinyl acetate in water, irradiating the emulsion in the absence of O_2 to a total dose of 1.20 to 2.32×10^4 r at 50 to -15°C, and recovering the resulting polyvinyl acetate. The intrinsic viscosity of the product is 1.7 to 3.2 dl/g. (D.L.C.)

3868 PREPARATION OF POLY-BETA-PROPIOLACTONE. Nelson S. Marans (to W. R. Grace and Co.). U. S. Patent 3,111,469. Nov. 19, 1963. Filed Apr. 5, 1961.

A process is described for the radio-polymerization of monomeric beta-propiolactone by a high-energy electron dose of 0.01 to 10 megarads. The monomeric beta-propiolactone is cooled to below its freezing point and maintained there during the irradiation. Afterwards the unpolymerized beta-propiolactone is removed immediately by filtration. Some physical properties of varied samples are given. (R.E.U.)

3869 SCAVENGING OF RADIOACTIVE AEROSOLS. Jan Rosinski and Donald K. Werle (to U. S. Atomic Energy Commission). U. S. Patent 3,113,007. Dec. 3, 1963.

A process of decontaminating an atmosphere from suspended radioactive particles by introducing silicon tetrafluoride whereby the particles precipitate and are removed, is described. (AEC)

3870 RAISING THE MELTING POINT OF POLYOLEFINS. James L. Lauer (to Sun Oil Co.). U. S. Patent 3,113,081. Dec. 3, 1963. Filed June 11, 1957.

The melting points of polypropylene and polybutene-1 were raised by exposure to controlled doses of gamma radiation. A normally solid polymer with a melting range of between 170 and 285°F was exposed to ionizing radiation at 2×10^8 rep. A polymer with a higher melting range than the unirradiated polymer was recovered. (M.C.G.)

3871 STANDARDIZATION OF ORGANIC COOLANTS AND MODERATORS IN NEUTRONIC REACTORS. Morris R. Ort and William H. Yanko (to Monsanto Chemical Co.). U. S. Patent 3,113,090. Filed Feb. 2, 1959.

Reactor moderators and/or coolants stabilized against residue formation due to radiation are described. A radiation-stabilized composition consisting essentially of nonfused-ring polyphenyls and about 2 to 20 mole % anthracene was developed. (M.C.G.)

3872 METHOD OF PREPARING RADIOACTIVE CESIUM SOURCES. T. C. Quinby (to U. S. Atomic Energy Commission). U. S. Patent 3,114,716. Dec. 17, 1963.

A method of preparing a cesium-containing radiation source with physical and chemical properties suitable for high-level use is presented. Finely divided silica is suspended in a solution containing cesium, normally the fission-product isotope cesium 137. Sodium tetraphenyl boron is then added to quantitatively precipitate the cesium. The cesium-containing precipitate is converted to borosilicate glass by heating to the melting point and cooling. Up to 60 weight percent cesium, with a resulting source activity of up to 21 curies per gram, is incorporated in the glass. (AEC)

3873 METHOD OF INHIBITING IRRADIATION-INDUCED VISCOSITY INCREASE OF ORGANIC FLUIDS. G. H. Denison, R. O. Bolt, J. W. Kent, and F. A. Christiansen (to U. S. Atomic Energy Commision). U. S. Patent 3,115,462. Dec. 24, 1963.

Methods of reducing radiation-induced thickening of lubricating oils are presented. In accordance with the invention a system subjected to nuclear radiation is lubricated with a lubricating oil containing an agent selected from phenyl dibutyl dithiophosphate, mercaptobenzothiazole, dihexacosyl polysulfide, and hexadecanethiol, preferably in the amount of 1 to 10 per cent by volume. (AEC)

3874 METHOD OF INHIBITING IRRADIATION-INDUCED VISCOSITY INCREASE OF ORGANIC FLUIDS. G. H. Denison, R. O. Bolt, J. W. Kent, F. A. Christiansen, and J. G. Carroll (to U. S. Atomic Energy Commission). U. S. Patent 3,115,467. Dec. 24, 1963.

Methods of reducing radiation-induced thickening of lubricating oils are presented. A system subjected to nuclear radiation is lubricated with an oil containing iodonaphthalene, preferably in the amount of 0.5 to 16 per cent by volume. (AEC)

Separation Processes and Procedures

3875 (BNL-7352) RECOVERY OF U FROM PYROLYTIC CARBON-COATED UC_2 SPHEROIDS. H. Katz and J. Wagner (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 15p. (CONF-117-21).

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

100% recovery of uranium from pyrolytic carbon-coated spheroids of uranium dicarbide was accomplished by an aqueous electrolytic process at the small scale laboratory level. This result was obtained in a system which circulated 1 molar nitric acid through a thin bed of the spheres. The bed was supported between a glass frit and the anode, with which the bed was in contact. The anode was a spiral of platinum wire; the cathode was a grid of tantalum wire. Current density was about 0.2 amp/cm^2 based on geometric surface area calculated from the average particle size of 150 microns. Initial flow rate was about 1.3 ml/cm^2/sec. Reaction temperature was 72 to 82°C; time was 15 hours. At $\frac{1}{8}$ the above current density and at the same temperature, recovery was smaller and was independent of concentration of nitric acid over the range 1 to 4 molar; also recovery in 1 molar ammonium nitrate was about the same as in 1 molar HNO_3. About a 100-fold increase in recovery was obtained by going from a convection stirred cell at 90°C to the pumped type of cell at 54°C using ammonium nitrate as the electrolyte. (auth)

3876 (HW-68268) EXAMINATION OF PUREX F-6 HEAT EXCHANGER FAILURE. W. L. Walker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 30, 1961. Contract AT(45-1)-1350. 19p.

After 18 months operation, tube bundle No. 17 from the east position of the Purex F-6 waste acid concentrator was removed from service because of apparent failure. The entire tube bundle was partially decontaminated, and a section was removed from the bottom portion of the heat exchanger for detailed examination. Examination of the sample section revealed that the bottom tube sheet had been corroded to a depth of $\frac{1}{16}$ to $\frac{1}{8}$ inch, except in the areas immediately adjacent to the tube welds. In addition, half of the 21 tubes included in the section had corroded to a depth of 50 to 60 mils; about one half the original wall thickness. The remaining tubes were corroded to a depth of only about 20 mils. No significant differences in composition were observed between the severely and slightly corroded tubes, and Huey test rates were almost identical. Two failures of tube-to-tube sheet welds were visible on the sample section, and several near failures were observed. Detailed examination of the entire bottom tube sheet was not possible, but at least four tube-to-tube sheet weld failures were visible in one of the photographs of the bottom tube sheet. Detailed examination of the tube-to-tube sheet joints on the sample section indicated that failure resulted from improper placement of the tube-to-tube sheet welds. No explanation of the lack of corrosion on half of the tubes available for examination could be offered from the data collected in this investigation, however, it could be postulated that solids accumulation on the wall of the tube might account for this. (auth)

3877 (HW-78651(Rev.)) DEVELOPMENT AND DEMONSTRATION OF AN ION-EXCHANGE PROCESS FOR KILOGRAM-SCALE PRODUCTION OF HIGH PURITY PROMETHIUM. E. J. Wheelwright and F. P. Roberts (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 46p.

An ion-exchange process for promethium purification was developed and successfully demonstrated in the Han-

ford Laboratories' High Level Radiochemical Facility. A crude rare earth fission product mixture containing 20,000 curies of Pm^{147} (from which the cerium had been removed by a previous precipitation process) was processed through a multicolumn ion-exchange unit. Dowex 50W, X-8 (50-100 mesh) resin was used and the rare earths were eluted with an NH_4OH buffered EDTA solution at elevated temperature. The distinguishing features of this process are the selection of a restraining ion and the elevated temperature operation, which permit purification of the promethium in a minimum amount of time, thus reducing resin radiolysis to an acceptable level. The promethium was recovered, radiochemically pure, in three fractions. The "heart" fraction, 13,000 curies, was 99% pure; the only contaminants being traces of neodymium and samarium. The second fraction, 3100 curies, contained 88% promethium, 1% samarium and 11% neodymium. The third fraction, 4600 curies, was 55% promethium, 24% samarium and 21% neodymium. The equipment and the operating conditions are described. The operating features of a full scale plant based upon the process are briefly noted. (auth)

3878 (IS-660) COUNTER CURRENT EXTRACTION IN SALT/METAL SYSTEMS INVOLVING OXIDATION-REDUCTION REACTIONS. P. Chiotti (Ames Lab., Ames, Iowa). June 1963. Contract W-7405-eng-82. 25p.

The separation of solutes by counter-current techniques in a two-phase system wherein the transfer of solutes between the two phases depends on an oxidation-reduction reaction of fixed stoichiometry is shown to be analogous to the separation of components in a distillation column. A flow diagram for separating two solutes, such as uranium and thorium, in a KCl–LiCl/zinc system is presented. Mathematical relations and graphical methods for determining the number of equilibrium stages required to effect a given separation are developed. The number of precipitate phases in the solvent streams must be limited for the counter-current system to be operative. (auth)

3879 (NP-13287) CRITICALLY SAFE MIXER-SETTLERS. J. Centeno (European Company for the Chemical Processing of Irradiated Fuels, Mol., Belgium). Mar. 30, 1962. 26p. (ETR-138)

A review of the most suitable types of mixer-settlers for processing concentrated solutions of fissionable materials is presented. The essential characteristics of the different types of extractors are compared. Critically safe design, efficiency prediction, and scaling-up methods are also considered. The horizontal slab type (stages assembled side by side) and turbine type (in-line assembly) mixer-settlers seem to be the most suitable as "ever-safe" extractors. For ease of maintenance, the air pulsed mixer-settler should be one of the types to be considered. (auth)

3880 (NP-13290) SOME SOLVENT EXTRACTION EQUILIBRIUM DATA FOR THE PROCESSING OF HIGHLY-ENRICHED URANIUM/ALUMINUM FUELS. J. Centeno and W. Drent (European Company for the Chemical Processing of Irradiated Fuels, Mol., Belgium). Nov. 1962. 38p. (ETR-143)

To evaluate the extraction flow sheets envisaged for processing enriched fuels at Eurochemic, some missing equilibrium data have been determined for uranium and nitric acid in 3.25% and 6% TBP/Shellsol-T systems. The study has been limited to the conditions for the extraction, scrub, and stripping operations proposed in ETR-113. (auth)

3881 (ORNL-TM-504) A PROCESS FOR RECOVERING IODINE-129. H. A. O'Brien, Jr. and J. M. Sullivan (Oak Ridge National Lab., Tenn.). Apr. 9, 1963. Contract W-7405-eng-26. 6p.

A process was developed on a laboratory scale for recovering, in 90 to 95% yield, I^{129} from Berl saddles impregnated with $AgNO_3$. The iodide ion is displaced from silver iodide by sulfide ion in alkaline solution, and I^{129} is distilled from the 1M NaOH–0.01M Na_2S solution after oxidation with hydrogen peroxide. (auth)

3882 (ORNL-TM-688) COMBUSTION-DISSOLUTION EXPERIMENTS WITH IRRADIATED GRAPHITE-BASE REACTOR FUEL CONTAINING CARBON-COATED THORIUM–URANIUM DICARBIDE PARTICLES. L. M. Ferris, K. S. Warren, J. W. Ullmann, L. A. Byrd, and C. T. Thompson (Oak Ridge National Lab., Tenn.). Sept. 20, 1963. Contract W-7405-eng-26. 16p.

Four small pieces of simulated HTGR fuel (from the GAIL-IIIA loop experiment) irradiated to approximately 10,000 Mwd/metric ton (U + Th) were burned in oxygen for 5 hr to determine fission product volatility and dissolubility of the ash. Two of the fuel pieces (C-coated Th–U dicarbide particles dispersed in a graphite matrix; Th/U ratio of about 2.5) were burned at 800°C; the other two at about 1200°C. Essentially no uranium, thorium, zirconium, or rare earths volatilized in any experiment. Greater than 78% of the ruthenium was volatile at 800°C and 97 to 99% at 1200°C. About 25 to 35% of the cesium vaporized at 800°C and 67 to 88% at 1200°C. The ThO_2–U_3O_8 combustion ash from the two 800°C runs was completely dissolved in 7 hr in refluxing 13M HNO_3–0.04M HF–0.04M $Al(NO_3)_3$; the final solutions were about 0.5M in Th. The ash from the 1200°C runs was slightly more refractory. In one case complete dissolution was achieved; but, in the other, only 97% was dissolved in the 7-hr period. The remaining 3% dissolved in a second 7-hr digestion with fresh reagent. The results of these preliminary experiments indicate that a Burn-Dissolve process for irradiated graphite-base reactor fuels is chemically feasible. (auth)

3883 (ORNL-TM-717) PROCESS DEVELOPMENTS IN THE ORNL FLUORIDE VOLATILITY PROGRAM, OCTOBER 1962–SEPTEMBER 1963. R. P. Milford (Oak Ridge National Lab., Tenn.). Oct. 25, 1963. Contract [W-7405-eng-26]. 22p.

The Volatility program at Oak Ridge National Laboratory for the year ending September 1963, is reviewed. The paper was presented September 23, 1963, at the Chemical Technology Division Annual Information Meeting. Volatility processes are also being investigated at Argonne and Brookhaven National Laboratories in the United States, and overseas, at least, in Belgium, France, and Japan. The ORNL effort recently has been primarily devoted to recovering enriched uranium from Zr–U fuels. The alloy is dissolved in molten salt with HF. The resulting UF_4 is converted to volatile UF_6 with F_2 and further purified by the sorbents NaF and MgF_2. During the year (1) fully irradiated long- and short-cooled Zr–U fuels were processed in the Volatility Pilot Plant with excellent results; (2) a molten-salt fluoride volatility process for aluminum alloy fuels was developed through the laboratory stage; (3) a heavy emphasis at an engineering scale was placed on a process involving a volatility step for graphite-base fuels; (4) an extensive series of economic evaluations was begun in the Engineering Development Department of the Oak Ridge Gaseous Diffusion Plant; (5) the feasibility of hydrofluorinating and fluorinating in the same vessel with re-

cycle of part of the waste salt was investigated from the standpoint of operability and container corrosion; (6) the removal of UF_6 from a gas stream containing UF_6 and nitrogen by a single layer of NaF pellets was studied; (7) a gasometer was developed to study the sorption of gas-phase fluorides by solids, especially NaF and MgF_2; (8) mechanisms for the removal of plutonium from LiF–NaF–ZrF_4 melts containing 1000 ppm plutonium were investigated; and (9) studies to minimize the corrosion of nickel-base alloys in the presence of F_2 or HF and fluoride melts were continued at ORNL and Battelle Memorial Institute. (auth)

3884 (TID-19728) SEPARATION EFFICIENCIES OF PULSED EXTRACTION COLUMNS. Progress Report No. 6, October 1, 1961–September 30, 1962. Albert L. Babb (Washington. Univ., Seattle. Coll. of Engineering). Oct. 1, 1962. Includes Appendix: MATHEMATICAL SIMULATION OF THE TRANSIENT BEHAVIOR OF A PULSED SOLVENT EXTRACTION COLUMN, Taken from Thesis by Francis H. Champagne. Contract AT(45-1)-1053. 144p.

Detailed studies were made on holdup, transient responses, and dispersed phase mixing in order to understand better inter- and intra-phase mass transfer processes that take place in a pulsed solvent extraction column. A probability model was developed for characterizing the axial mixing in dispersed phases. The model was used as the basis for the design of experiments using Co^{60} as a tracer to measure the dispersed phase Peclet numbers. Studies of computer simulation of steady state pulsed column operation by analog and digital methods were made. A mathematical study was made of the transient response of a pulsed column. A unique experimental technique was developed that enables the effect of changing the radial velocity distribution of an electrolyte flowing in a tube at constant mass velocity to be made. A computer program is also included. (P.C.H.)

3885 (AEC-tr-6156) EXTRACTION OF PLUTONIUM. DECLADDING PLANT. M. Allès. Translated for Oak Ridge National Lab., from Energie Nucl., 5: 257-62 (1963). 16p.

For four years the present decladding installations have not ceased their production at increasing rates without failure or notable shutdowns. A tremendous quantity of curies has passed through this building and its 100 employees have handled thousands of slugs. This is a fact which deserves emphasis: in the frequent spectroscopic checks made periodically on the personnel, no peculiarity could be found. When it is considered that the contamination possibilities are very great, the result obtained can be considered very satisfactory. (auth)

3886 (AEC-tr-6177) "PUREX" OR "VOLATILIZATION" INFLUENCE OF THE REPROCESSING PROCESS ON THE FUEL CYCLE. P. Regnaut and J. Sauteron (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Translation of paper presented at the Colloquim "Fuel Cycles for Power Reactors," Baden-Baden, Germany, September 9-14, 1963. 35p.

Principal advantages and disadvantages of reprocessing by the aqueous route and by the dry route are reviewed. A comparison is made of processes by the dry route and justification is given for the French choice: volatilization of fluorides by attack in the gas phase, followed by distillation of hexafluorides. A review of French studies in this field and large outlines of the processes investigated are given. A description is given of the hot cell project for experimentation with irradiated rods. The volatilization process with the aqueous process are compared: (1) For different fuels (alloys, oxide, fuels enriched with plutonium). (2) In the case of enriched uranium fuels for different purposes: reconversion into oxide, metal or hexafluoride for recycling to the gaseous diffusion plant. A qualitative examination is made of investments and operating costs. The volatilization process should lead to lower investment costs, due to the compactness of plants, but the high price of fluorine makes this process economically feasible only for fuels which are enriched with uranium-235 or plutonium. (auth)

3887 THE INFLUENCE OF IRON MINERALS CONTAINED IN THE ORES ON THE OXIDATION OF URANIUM IN ACID MEDIUM. G. M. Alkhazashvili, G. M. Nesmeyanova, and L. N. Kuz'mina. At. Energ. (USSR), 15: 313-17 (Oct. 1963). (In Russian)

The various minerals present in U ores must be taken into account when developing the proper leaching treatment. If Fe ores are added to the U ores together with an oxidizer, such as MnO_2, during the treatment with H_2SO_4, the dissolution of U is enhanced and at 90° all the U is leached out. The effect of siderite, magnetite, limonite, and hematite on the dissolution of U-containing pitchblende in a mixture of 15% HNO_3–85% H_2SO_4 in the acid concentration range from 5 to 50 g/liter is very slight, but it increases rapidly if the acid concentration is raised to 100 g/liter. At 90°C, the ferric minerals affect the process to a greater extent than Fe(III)-containing ores. The unoxidized Fe(II) ions retard the oxidation of U(IV) by HNO_3. In investigating the effect of covellite on the dissolution rate of U at a U:Cu ratio of 1:0.55 in the presence of MnO_2, the amount of leached-out U was found to increase at all H_2SO_4 concentrations. It was concluded that the dissolution of pitchblende in H_2SO_4 containing MnO_2 and HNO_3 as oxidizers, is accelerated by the addition of Fe and Cu minerals. Among the ferric minerals, limonite, and among the ferrous ones, siderite, exert the greatest effect. At low acid concentrations of the H_2SO_4–HNO_3 mixture, the ferrous ions exert an inhibiting effect. (TTT)

3888 THE SEPARATION OF THE RARE EARTHS BY PARTITION CHROMATOGRAPHY WITH REVERSED PHASES. PART I. BEHAVIOUR OF COLUMN MATERIAL. T. B. Pierce and R. S. Hobbs (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chromatog., 12: 74-80(Sept. 1963).

The complexing agent di-(2-ethylhexyl) orthophosphoric acid, which is known to have a good average separation factor for adjacent rare earths, was retained on a poly-(vinyl chloride/vinyl acetate) copolymer, and this mixture used as column material for chromatographic elution of the rare earths. This column material can be conveniently prepared with reproducible behavior, sharp elution peaks being obtained at a running temperature of 60°, and a third power dependency of $(I/R_F - I)$ upon the hydrogen ion concentration of the eluting phase was found at several different loadings of the polymer with complexing agents. (auth)

3889 THE SEPARATION OF THE RARE EARTHS BY PARTITION CHROMATOGRAPHY WITH REVERSED PHASES. PART II. BEHAVIOUR OF INDIVIDUAL ELEMENTS ON HDEHP-CORVIC COLUMNS. T. B. Pierce, P. F. Peck, and R. S. Hobbs (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chromatog., 12: 81-8(Sept. 1963).

The elements lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium were eluted by perchloric and hydrochloric acid of different strengths from columns of di-(2-

ethylhexyl) orthophosphoric acid retained on a poly-(vinyl chloride/vinyl acetate) copolymer. From the results separation factors were calculated and were compared with values obtained from solvent extraction determinations with the alkyl-phosphoric acid dissolved in toluene. (auth)

3890 SEPARATION OF IODINE AND STEAM AT ELEVATED TEMPERATURES. P. J. Kreijger and Th. van der Plas (Euratom-R.C.N., Arnhem, Netherlands). J. Nucl. Energy, Pt. A & B, 17: 377-84(Nov. 1963).

The separation of small amounts of iodine and steam in a stainless-steel rectifying column is studied between 120 and 275°C. It is found that under the experimental conditions at high temperatures (275°C) a nearly complete separation between iodine and water can be obtained, whereas this separation becomes more difficult at lower temperatures. At 120°C no separation is possible. The mechanism leading to the separation is a combined effect of chemical reaction and distillation. In connection with this work a direct determination of the phase equilibrium constant of I_2 and water at 100°C is carried out. (auth)

3891 THE SEPARATION AND PRECISE COMPARATIVE DETERMINATION OF Np^{239} IN IRRADIATED LOW-ENRICHMENT URANIUM OXIDE FOILS AND PELLETS. G. A. Barnett, W. A. V. Brown, and D. J. Ferrett (Atomic Energy Establishment, Winfrith, Dorset, Eng.). J. Nucl. Energy, Pt. A & B, 17: 389-93(Nov. 1963). (AEEW-R-202)

A technique for the comparative assessment of U^{238} neutron capture entails a precise determination of the Np^{239} produced in irradiated uranium oxide foils or pellets. The irradiated sample is dissolved in nitric acid and the Np^{239} present is chemically equilibrated with Np^{237} α-tracer. After reduction to the IV state by boiling with formic acid in a hydrochloric acid medium, these two isotopes are separated by a double TTA solvent extraction from uranium, fission products, and Pa^{233}, which is the daughter of the Np^{237} α-tracer. The two neptunium isotopes are electrodeposited on a stainless steel disk with an initial addition of 50 μg of nonirradiated natural uranium. This addition results in a linear relationship (as a function of source mass) between the α-count of the Np^{237} as measured on a scintillation counter and the total β-count of the Np^{239} as measured on an end-window gas proportional counter. The method has a working precision of 2 per cent (2σ) and is suitable for samples that do not have a previous irradiation history. (auth)

3892 THE PREPARATION OF CARRIER-FREE THORIUM-234. Jaroslav Benes (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 9: 324-6(Oct. 1963). (In Czech)

The possibilities of the isolation (from uranyl nitrate) of radioactive thorium used for dosimetric and tracer purposes were investigated. With the use of strong basic anion exchanger the Th^{234} was obtained carrier-free, radiochemically pure, in small volume, and with low evaporation residua. (auth)

3893 REPROCESSING OF UO_2-DISPERSED GRAPHITE FUELS. IV. ELECTROCHEMICAL DISINTEGRATION OF FUEL PELLETS. Junichi Shimokawa and Masao Mishima (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 841-6(Oct. 1963).

The electrochemical disintegration method was applied to the processing of irradiated UO_2–graphite fuel elements, in which most of the fission products were in the graphite matrix by fission recoil. A graphite pellet, 9 mm dia., by 10 mm long, was made an anode in a 100 ml squat beaker containing nitric acid solution. The cathode was usually a plate of platinum. Investigations were carried out for the disintegration behavior of fuel-pellets, recovery of uranium, and release of fission products from the graphite base. (auth)

3894 RADIONUCLIDES IN FOODS AND AGRICULTURAL PRODUCTS. MILK PRODUCTION AND DAIRY PRODUCTS PROCESSING. Frank A. Todd (Dept. of Agriculture, Washington, D. C.). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 24-30(1963).

A brief review is presented on the potential problems that radioactive fallout might provide to the dairy industry, including available measures, and current research being conducted, to reduce radionuclides in milk, if such is required. Research on countermeasures for radioiodine and radiostrontium conducted by the Agricultural Research Service and in cooperation with the AEC and the Public Health Service are discussed. The removal of dairy cows from pasture and the use of stored feed is a very effective means of reducing iodine-131 in milk. Additional research, however, is necessary to develop methods of preventing contamination of milk with iodine-131 when stored feeds are not readily available. The removal of iodine-131 by means of an ion exchange process is being studied and adapted to a pilot plant procedure. The removal of strontium-90 from milk by use of an ion exchange resin has been developed on a pilot plant scale. The procedure is now being adapted to commercial scale. Additional studies are required to determine the effect which any possible changes in the minor components would have on the nutritional qualities of the milk. The microbiological problems that might be associated with the resin treatment process must be determined. Continued research is necessary to determine the optimum conditions of strontium removal both from the standpoint of completeness and economy. Research problems relative to dairy cattle rations and farming practices that need to be studied are identified. (auth)

3895 INDUSTRIAL PROCESSES FOR THE REMOVAL OF RADIONUCLIDES FROM MILK. J. E. Campbell (Robert A. Taft Sanitary Engineering Center, Cincinnati). Ohio Agr. Expt. Sta., Spec. Rept. Ser. No. 1, 81-94(1963).

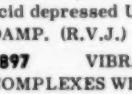
Although 160 to 170 fission products are produced as a result of a nuclear detonation, only I^{131}, Sr^{89}, Sr^{90}, Cs^{137}, and Ba^{140} are of any consequence in relation to milk. The effect of treating milk with resins charged with 5X-CaMgKNa and 10X-CaMgKNa salt solutions was investigated, and it was found that while a constant removal of 90–95% Sr^{85} was obtained in both columns from up to 25 resin-bed volumes of milk, the cationic composition of milk from the 5X-CaMgKNa resin column remained essentially the same. Studies on radionuclide removal via acidification of milk showed that removal of Sr^{85} and Ba^{140} are affected by acidification, whereas Cs^{137} removal is not. Removal of Sr^{85} from milk labeled in vitro did not differ significantly from that labeled in vivo. Determination of the number of resin-bed volumes effective in radionuclide removal showed a constant removal of 94 ± 2% of Sr^{85} and 92 ± 2% of Ba^{140} with up to 30 resin-bed volumes of milk, beyond which a gradual decrease was observed. However, Cs^{134} removal decreased from 98 to 0 percent with increased resin-bed volumes of milk from 5 to 50. A method of neutralization and second resin treatment was developed for Cs^{134} removal from milk. Several fresh samples of raw whole milk were acidified, resin-treated, and neutralized. Addition of a rennet solution to these samples resulted in no coagulation, thus indicating that calcium was unavailable for the formation of coagulum. Fresh raw whole milk was divided into several portions,

acidified to different pH values, resin-treated, and neutralized. Organoleptic quality of milk treated in this manner was judged to be comparable to that of normal pasteurized milk. Although ion exchange resins are suitable for removal of cationic radionuclides from milk, applicability of the process to commercial operations is yet to be assessed. (H.M.G.)

3896 MIXTURES OF MONO- AND DI(2,4-DIETHYLOCTYL-1) METHYLPHOSPHONATES AND THEIR EXTRACTION PROPERTIES. B. N. Laskorin, D. I. Skorovarov, E. A. Filippov, and A. I. Shilin. Radiokhimiya, 5: 424-8(1963). (In Russian)

Preparation of mono- and di-(2,4-diethyloctyl-1) methylphosphonates (MLMPA and DLMP) by reactions of 2,4-diethyloctanol-1 with methylphosphonic acid dichloranhydride is described. A maximum yield of monoalkyl methylphosphonate was reached at 45° synthesis temperature. Mixtures of mono(2,4-diethyloctyl-1) methylphosphonate with neutral phosphororganic compounds exhibit improved solvent properties for U(VI). Phosphoric acid depressed U(VI) extraction by MLMPA with TBP and DAMP. (R.V.J.)

3897 VIBRATIONAL SPECTRA OF ZIRCONIUM COMPLEXES WITH PHOSPHORORGANIC DERIVATIONS. I. EXTRACTION SPECTRA FROM HYDROCHLORIC AND NITRIC ACID SOLUTIONS. G. P. Nikitina and M. F. Pushlenkov. Radiokhimiya, 5: 436-45(1963). (In Russian)

Structure and composition of Zr compounds extracted from hydrochloric and nitric acid solutions into tri-n-butylphosphine oxide in CCl_4 are described by the following formula: $ZrA_4 \cdot 2TBPO$ (where A = Cl^- and NO_3^-). The structure of extracted complex is: $(C_4H_9)_3 \rightarrow P \rightarrow O \rightarrow$  $\leftarrow O \leftarrow P \leftarrow (C_4H_9)_3$. Stoichiometric zirconium extraction from nitric acid solutions is expressed as: $Zr(OH)_2^{2+} + 2H^+ + 4NO_3^- + 2T \rightleftharpoons Zr(NO_3)_4 \cdot 2T + 2H_2O$. The structure and composition of the Zr compounds are discussed. (R.V.J.)

3898 VIBRATIONAL SPECTRA OF ZIRCONIUM COMPLEXES WITH PHOSPHORORGANIC DERIVATIVES. II. ZIRCONIUM TETRACHLORIDE COMPLEXES. G. P. Nikitina and M. F. Pushlenkov. Radiokhimiya, 5: 456-64 (1963). (In Russian)

Infrared spectra and composition of $ZrCl_4$ complexes with tri-n-butyl phosphate (TBP), di-n-butyl ester of n-butylphosphinic acid (DBEBP), n-butyl ester of di-n-butylphosphinic acid (BEDBP), and tri-n-butylphosphine oxide (TBPO) were determined. It is shown that $ZrCl_4$ with TBP and TBPO compounds form dissolvates with a general formula $ZrCl_4 \cdot 2T$ (where T = TBP, DBEBP, DEDBP, and TBPO). The structure of the complex compounds seemed to be identical with $P \rightarrow O \rightarrow ZrCl_4 \leftarrow O \leftarrow P$. (R.V.J.)

3899 EXTRACTION OF THORIUM FROM NITRIC ACID BY DIBUTYL PHOSPHORIC ACID. Z. A. Sheka and E. I. Sinyavskaya. Radiokhimiya, 5: 485-90(1963). (In Russian)

Equilibrium constants were determined for thorium extraction from nitric acid solution by dibutyl phosphoric acid in carbon tetrachloride. It is shown that thorium-DBP is more stable than similar lanthanoid compounds. (R.V.J.)

3900 SEPARATION OF SMALL QUANTITIES OF THORIUM FROM RARE EARTH ELEMENTS, IRON, AND ALUMINUM BY ION EXCHANGE RESIN WITH ABSORBED REAGENT. V. A. Nazarenko, E. A. Biryuk, and E. N. Poluektova. Radiokhimiya, 5: 497-9(1963). (In Russian)

A treatment of anionite with an organic reagent sensitive to a specific element transformed the anionite into cationite capable of selective absorption of the element actively reacting with the reagent. It is shown that microgram quantities of thorium can be separated from gram quantities of rare earths, aluminum and iron by means of cationite AB-17 saturated with thoron. The method was used for determining to 10^{-4}% thorium admixtures in oxides and rare earth salts. (R.V.J.)

3901 AN EXPRESSION FOR THE LAW OF DISTRIBUTION IN EXTRACTION EXPERIMENTS. V. I. Levin. Radiokhimiya, 5: 505-7(1963). (In Russian)

A correct form is suggested for expressing the uranyl-nitrate distribution coefficient between two liquid phases (of extracted substance and the extracting agent) indicating the participation of both solvents. (R.V.J.)

3902 THE EXTRACTION OF HEAVY METALS, PARTICULARLY OF URANIUM, FROM LOW-GRADE ORES USING CHLORINE GAS. PART 2. Walther Kangro. Z. Erzbergbau Metallhuttenw., 16: 328-35(July 1963). (In German)

Techniques for the extraction and separation of U, V, Pb, Fe, Ra, and Th from low-grade ores by selective chlorination are described. A flow chart is given for the entire extraction technology from ore dressing to the products. (TCO)

3903 A SIMPLE METHOD FOR THE SEPARATION OF RADIOACTIVE STRONTIUM AND BARIUM. E. Bakacs-Polgar (Bokach-Polgar) and I. Kurcz-Csiky (Kurtz-Chiki) (State Inst. of Hygiene, Budapest). Zh. Analit. Khim., 18: 1206-10(Oct. 1963). (In Russian)

A simple method for the separation of radioactive strontium and barium occurring in rainfall is described. The sample can be prepared for measurement in one or two days and since quantitative separation is not required, the filtration may be performed directly after cooling. Dangerous chemicals, such as fuming nitric acid, concentrated hydrochloric acid, and ether are not necessary. Determinations can be carried out by means of simple laboratory instruments. Barium activity, which is of major importance to determine the time of atomic explosions, can be measured directly. If the $BaCrO_4$ precipitate is active, contamination cannot be the result of a former explosion, for $T_{Ba^{140}} = 12.8$ days. The method is sufficiently accurate; activity shown by measurements was not less than 93% in relation to calculated activity. (auth)

3904 ELECTROLYTIC SEPARATION OF NICKEL FROM SOLUTIONS CONTAINING THORIUM SALTS. T. V. Tsyvenkova, P. N. Kovalenko, and Z. I. Ivanova (Rostov State Univ., USSR). Zh. Analit. Khim., 18: 1222-7(Oct. 1963). (In Russian)

Optimum conditions were found for quantitative electrolytic precipitation of nickel from solutions containing thorium salts. An emission spectrographic method was used to study the purity of the nickel electrolytic precipitate. The sensitivity of thorium determination in the precipitate is 6.8×10^{-5} g-ion/l. It is shown that, when nickel is separated under optimum conditions, no coprecipitation of thorium takes place. (auth)

3905 INORGANIC CHEMISTRY IN PROCESS DEVELOPMENT AND DESIGN OF METALLURGICAL SOLVENT EXTRACTION SYSTEMS. G. H. Clewett (Union Carbide Nuclear Co., Tuxedo, N. Y.). 21p. (CONF-117-26)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Discussion is presented on variables that can be manipulated in the development of a solvent extraction process to

do a particular job. Redox potential, complexing agents, pH, diluent effects, and synergistic effects are considered. (P.C.H.)

3906 IMPROVEMENTS IN AND RELATING TO SEPARATION OF ZIRCONIUM AND HAFNIUM. Wayne Hicks Keller (to National Research Corp.). British Patent 941,125. Nov. 6, 1963. Filed July 29, 1963.

The liquid-liquid extraction of zirconium and hafnium to provide a product zirconium stream that is essentially free of contained hafnium is described. An acidified aqueous solution of zirconium with contained hafnium is fed to an extraction column containing an organic extractant that is fed near the bottom of the column. The organic extractant rises in the column and the acidified water is passed down the column concurrent to the organic flow. Zirconium selectively transfers to the organic phase while the hafnium tends to remain in the aqueous phase. The system is particularly described using zirconyl nitrate containing hafnyl nitrate as an impurity, a rotary disc contractor column, and an organic stream of TBP diluted with an equal volume of a hydrocarbon mixture. (R.E.U.)

3907 RECOVERY OF RHODIUM FROM FISSION PRODUCTS. (to Engelhard Industries, Inc.). British Patent 941,985. Nov. 20, 1963. Priority date Mar. 4, 1959, United States.

A process was developed for the separation of rhodium from fission products in waste streams from hot uranium reprocessing plants. The stable rhodium is isolated by first separating its parent Ru^{103}. The aqueous waste is treated in such a manner as to distill out the ruthenium tetroxide, which is reduced to ruthenium hydrated oxide or metallic ruthenium and allowed to stand for about one year. Its 40-day half life results in virtually complete conversion to Rh^{103} in this period. After the elapse of a year of storage, the residual ruthenium is removed by distillation, leaving the rhodium present as metal free of long-lived radioactive impurities. (M.C.G.)

3908 RECOVERY OF RHODIUM FROM FISSION PRODUCTS. (to Engelhard Industries, Inc.). British Patent 941,986. Nov. 20, 1963. Priority date Mar. 4, 1959, United States.

A process for recovering rhodium from fission products was developed. An aqueous solution of the fission products is treated so as to precipitate rhodium as a sulfide. The rhodium sulfide is redissolved and converted to a base-soluble complex rhodium salt. The pH of the solution is adjusted to the alkaline range to remove base-insoluble constituents, after which the filtrate is converted to chloride. Ruthenium and other volatile fission products are removed by distillation, and the rhodium chloride is reduced to rhodium metal. (M.C.G.)

3909 PRODUCTION OF GRANULAR ZIRCONIA PRODUCTS. (to National Lead Co.). British Patent 942,079. Nov. 20, 1963. Priority date Dec. 31, 1959, United States.

A process for producing low-silica zirconia grain or powder directly from zircon or other zirconia ores is described. A mixture of a silica-containing zirconium ore, carbon, and an oxide or oxide-forming compound of an alkaline earth metal, including magnesium, is heated to at least 4500°F in an arc furnace in the presence of nitrogen to dissociate the zirconium silicate present, to vaporize substantially all of the silica present in the mixture, and to form a fused pig of the complex, reduced zirconium product. This product is subjected to oxidizing conditions while at a temperature of at least 1500°F to oxidize the zirconium cyanonitride present and to cause the product to disintegrate into a granular material. (M.C.G.)

3910 PRODUCTION OF BERYLLIUM COMPOUNDS FROM BERYLLIUM ORE. Remo A. Opatowski. Canadian Patent 663,776. May 28, 1963. Filed Feb. 19, 1962.

A process is outlined for recovering Be from low-grade Be ores. In the process, the wet, ground ore is mixed with ammonium bisulfate and heated to transform the Be in the ore to $BeSO_4$, which is leached from the ore by water. The $BeSO_4$ may then be converted to other Be compounds. The ore has to be rendered susceptible to attack by an acid radical prior to the process. Process flowsheets are given. (D.L.C.)

3911 BERYLLIUM OXIDE EXTRACTION PROCESS. Wendell J. Biermann (to Beryloy Ltd.). Canadian Patent 666,610. July 9, 1963. Filed Apr. 19, 1961.

A process for directly extracting BeO from ores is described which is very simple and inexpensive and does not involve a large number of extraction steps or reagents. The process is based on the discovery that BeO but not Al_2O_3 is soluble in a concentrated $BeSO_4$ solution. In the process, the ore is fused and then treated with a saturated $BeSO_4$ solution for 6 hr at 180°C. (D.L.C.)

3912 PLANT FOR LIQUID-LIQUID EXTRACTION BY THE COUNTERCURRENT FLOW PROCESS. Pierre Faugeras, Paul Minart, Pierre Pouchot, and Xavier Talmont (to Commissariat à l'Énergie Atomique). Canadian Patent 667,845. July 30, 1963. Priority date May 19, 1961, France.

A plant for rapid liquid-liquid extraction by the countercurrent flow process is designed which comprises a number of stages arranged in a cascade. Each stage comprises successively an ejector nozzle which mixes the phases and injects them into a cyclone, if necessary a coalescence tube fitted at the upstream end of the cyclone, a cyclone for separating the phases, and means for extracting energy from one or both of the liquids to operate the ejector nozzles. An example of the utilization of the plant is given using a uranyl nitrate solution and a solution of TBP in dodecane. (D.L.C.)

3913 METHODS AND MACHINES FOR SEPARATING FROM THEIR JACKETS IRRADIATED NUCLEAR FUEL SLUGS. Pierre Dabernard and René Guilloteau (to Commissariat à l'Énergie Atomique). Canadian Patent 672,051. Oct. 8, 1963. Priority date June 13, 1960, France.

A method and a machine for separating jackets from irradiated fuel slugs for reprocessing, are described which reduces the number of operations. In this method, the jacket cutting operation is performed after the jacketed slugs have been placed in position for the extrusion operation (pushing out from cut jacket). The operation of the machine is described in detail. (D.L.C.)

3914 PROCESS OF PREPARATION OF URANIUM COMPOUNDS FROM URANIUM–MOLYBDENUM ALLOYS. Michel Bourgeois and Pierre Faugeras (to Commissariat à l'Énergie Atomique). Canadian Patent 672,926. Oct. 22, 1963. Priority date Aug. 3, 1960, France.

A process is given for preparing, from U–Mo alloys, U compounds which are practically free from Mo. The process comprises heating the alloy to 100 to 300°C and then treating the alloy with a gaseous mixture of HCl or HF and O_2. Mo is volatilized as the oxyhalide, while U remains in the residue as an oxide (when HCl is used) or oxyfluoride and tetrafluoride (when HF is used). ~90% of the Mo is eliminated in this way, and the U residue may then be fluorinated to give UF_6. The effects of variables on the reaction rates are discussed. (D.L.C.)

3915 PROCESS FOR OBTAINING PLUTONIUM IN THE FORM OF A CONCENTRATED SOLUTION. André Chesne (to Commissariat à l'Énergie Atomique). Canadian Patent 672,928. Oct. 22, 1963. Priority date Aug. 17, 1960, France.

A process is given for obtaining a concentrated Pu solution from an aqueous acid solution of irradiated nuclear fuel. The process comprises extracting Pu^{4+} from the fuel solution by a dilute tertiary amine in an organic phase and then washing the organic phase with an aqueous solution of acidity greater than 0.1 N and of a redox potential sufficient to maintain Pu in the tetravalent state. The re-extracting acid solution is preferably a mixture of H_2SO_4 and HNO_3. (D.L.C.)

3916 PROCESS FOR THE SEPARATION OF THORIUM, CERIUM, AND RARE EARTHS STARTING FROM THEIR OXIDES OR HYDROXIDES. Friedrich Gottdenker and Pawel Krumholz. U. S. Patent 3,111,375. Nov. 19, 1963. Priority date Sept. 2, 1957, Brazil.

The oxide and hydroxide mixture of thorium, cerium, and rare earths is first oxidized at above 100°C so as to convert the cerium to tetravalent ceric oxide. This oxide is treated with hydrochloric or nitric acid to pH 2 or 3 to dissolve the rare earths and to precipitate insoluble thorium and tetravalent cerium compounds. The pH is then adjusted to 4 or 5 and a reduction agent is added. The thorium compounds are precipitated and the cerium compounds remain singularly. (R.E.U.)

3917 RECOVERING METALS FROM AQUEOUS SULFATE SOLUTIONS. József Kerti. U. S. Patent 3,111,468. Nov. 19, 1963. Filed Aug. 30, 1961.

A process is described for recovering a metal located in the electrochemical-potential series between hydrogen and zinc and forming a sulfate salt highly soluble in water from an aqueous solution of the salt. During the hydroelectrometallurgical deposition of the metal from the aqueous solution of the metal sulfate, a metal electrode insoluble in the electrolyte and capable of reversibly participating in the sulfate-forming anodic reaction is used as an anode. Some examples cited are: production of nickel from raw material consisting of sulfides of nickel, the regeneration of iron-pickling solutions, and preparation of the negative mass of cadmium-nickel storage cells. (R.E.U.)

3918 PROCESS FOR SEPARATING CERIUM FROM TRIVALENT RARE EARTHS. Pawel Krumholz. U. S. Patent 3,112,990. Dec. 3, 1963. Priority date Sept. 2, 1957, Brazil.

A method for separating cerium from other rare earths is described. An aqueous suspension of hydroxides, carbonates, or oxides of the materials is treated with chlorine in a quantity only slightly higher than that necessary for oxidation of the cerium contained in the mixture. Hydrochloric acid is added until most of the trivalent rare earths are dissolved, while most of the cerium remains insoluble in the form of a basic chloride of quadrivalent cerium. (M.C.G.)

3919 A METHOD OF PREPARING URANIUM DIOXIDE. Frederick A. Scott and Lyle K. Mudge (to U. S. Atomic Energy Commission). U. S. Patent 3,114,682. Dec. 17, 1963.

A process of purifying raw, in particular plutonium- and fission-products-containing, uranium dioxide is described. The uranium dioxide is dissolved in a molten chloride mixture containing potassium chloride plus sodium, lithium, magnesium, or lead chloride under anhydrous conditions; an electric current and a chlorinating gas are passed through the mixture whereby pure uranium dioxide is deposited on and at the same time partially redissolved from the cathode. (AEC)

ENGINEERING

General

Refer also to abstracts 4026, 4059, and 4215.

3920 (NAA-SR-Memo-8800) EQUATIONS OF MOTION FOR A FLEXIBLE SHAFT ON TWO NON-LINEAR BEARINGS FOR CONDITIONS NOT NECESSARILY SYNCHRONOUS. P. B. Abramson and R. F. Ruffalo (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 24, 1963. Contract [AT(11-1)-Gen-8]. 15p.

In previous analyses of bearing and shaft dynamics, the basic assumption was that mass eccentricity (i.e., imperfectly balanced shaft) exists and causes the system to undergo purely synchronous whirl. Although the mass-eccentricity-created synchronous component of vibration is predominant, there exist self-excited components (due to deflections and bearing non-linearities) which are not necessarily negligible. Towards this end, equations of motion are set up assuming that the two bearings have different whirl patterns and different whirl speeds. If final results show that these two are identical, so much the better, for all future investigations may then validly assume synchronous conditions. General equations and methods of solution which were tried and impasses which were reached for a two-mass two-bearing shaft are presented. (auth)

3921 (TID-15244(Rev.)) ARCHITECTURAL AND CIVIL STANDARDS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 496p. (HWS-10000)

Hanford Atomic Production Operation specification guides and standards for architectural and civil engineering are presented. Information includes construction of roads, railroads, roofs, signs, buildings, building equipment, sewers, fences, safety systems, and drainage systems. Details of this manual are given in TID-4100 (Suppl.). (N.W.R.)

3922 (TID-15245(Rev.)) SAFETY-MECHANICAL STANDARDS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Contract AT(45-1)-1350. 324p. (HWS-10001)

Hanford Atomic Production Operation specification guides and standards for plumbing, chemical engineering, mechanical engineering, sanitary engineering, exhaust systems, steam engineering, stainless steel, dry boxes, thermal insulation, filtration, and materials testing are presented. Details of this manual are given in TID-4100 (Suppl.). (N.W.R.)

3923 (TID-15246(Vol.I)(Rev.)) DESIGN GUIDES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 471p. (HWS-10003-1)

Hanford Atomic Production Operation specification guides for chemical, civil, electrical, mechanical, structural, steam, and metallurgical engineering are presented. Information is included on piping, valves, packing and gasket materials, stainless steel, tanks, compressed air, painting, and roads. Details of this manual are given in TID-4100(Suppl.). (N.W.R.)

3924 (TID-15246(Vol.II)(Rev.)) GUIDES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 268p. (HWS-10003-2)

Hanford Atomic Production Operation specification guides for equipment and procedures, instrumentation, structural engineering, welding, design criteria, electrical engineering, and construction repairs are presented. Details of this manual are given in TID-4100(Suppl.). (N.W.R.)

3925 (TID-19753) STANDARD DESIGN CRITERIA. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 216p. (HWS-10006)

Hanford Atomic Production Operation specification guides for design criteria, structural engineering, civil engineering, heating, ventilation, air conditioning, fire alarm systems, noise control, lighting, railroad construction, corrosion protection, and electrical engineering are presented. Details of this manual are given in TID-4100 (Suppl.). (N.W.R.)

3926 (TID-19755) COMPOSITE INDEX OF HANFORD ENGINEERING STANDARDS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 52p. (HWS-10007(Index))

Hanford Atomic Production Operation composite index refers to subjects contained in the nine handbooks and manuals published under the Hanford Engineering Standard Program. This index is described in TID-4100(Suppl.). (N.W.R.)

3927 BRAZED OR SOLDERED JOINTS. (to Sulzer Freres, Société Anonyme). British Patent 942,164. Nov. 20, 1963. Priority date Sept. 1, 1960, Switzerland.

Brazed or soldered joints between two cylindrical metal members, one of which fits into the other with a capillary gap between them filled by the brass or solder are described. The layer-diameter member has a terminal portion that is of greater internal diameter than the portion bounding the capillary gap for the introduction of the brass or solder. This terminal portion ensures that the two members can be fitted one inside another without tilting. (M.C.G.)

3928 REPRODUCTION OF PRINTED MATTER USING THERMAL NEUTRONS. Ralph F. Lumb (to Moore Business Forms, Inc.). U. S. Patent 3,111,583. Nov. 19, 1963. Filed Feb. 9, 1960.

The method is based upon the reaction of thermal neutrons with some substance such as boron or lithium to produce high-energy alpha or beta particles that in turn act upon a sensitized sheet bearing a photographic layer of material to produce the image of the copy of printed or written matter. The master copy is made using inks into which the boron or lithium is incorporated. The device for irradiation of the master copy is described. (R.E.U.)

3929 BOMB STABILIZING STRUCTURE. J. L. Kelley and C. E. Runyan (to U. S. Atomic Energy Commission). U. S. Patent 3,113,517. Dec. 10, 1963.

A stabilizing structure capable of minimizing deviations of a falling body such as a bomb from desired trajectory is described. The structure comprises a fin or shroud arrangement of double-wedge configuration, the feeding portion being of narrow wedge shape and the after portion being of a wider wedge shape. The structure provides a force component for keeping the body on essentially desired trajectory throughout its fall. (AEC)

Applications of Nuclear Explosions

3930 PROJECT CHARIOT. A Complete Report on the Probable Gains and Risks of the AEC's Plowshare Project in Alaska. Nucl. Inform., 3: Nos. 4, 5, 6, 7, 1-20 (June 1961).

A survey of facts on Project Chariot is presented. The purpose, predictions of fallout, and biological risks are discussed. Cape Thompson and its people, animals, marine animals, birds, fish, and plants are described. (M.C.G.)

Facilities and Equipment

Refer also to abstracts 4025 and 4214.

3931 (HW-74093) DESIGN OF INDUCTION HEATING COILS FOR CYLINDRICAL CHARGES. G. Jansen, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 16, 1962. Contract AT(45-1)-1350. 143p.

A detailed procedure and an example calculation for matching induction heating coils with hollow cylindrical charges are given. Modifications of this method are presented for solid charges and charges protected by thin conductive shields. The calculational procedure has been programed on an IBM 7090 computer. The results of 2300 computer-calculated cases of coil matching to hollow cylindrical charges are presented in tabular form. The ranges of variables covered in the table are 15 to 50 kilowatts power, 1 to 10 kilocycles frequency, 220 to 440 volts, 3 to 48 inch charge diameter, charge length-to-diameter ratios of 0.5 to 20 and coil-to-charge air gaps of 0.5 to 4 inches. Other variables were held constant at fixed values. The number of turns in the coil, the electrical efficiency of heating, and the capacitance for tuning the coil are shown graphically over a selected range of the independent variables. Examination of the equations for induction heating reveals approximate relationships between the variables which are useful in qualitatively showing the effects of each variable. The exponents of dependency of dependent variables on independent variables in practical operating regions are shown. (auth)

3932 (NVO-162-4) MULTI-PURPOSE IRRADIATOR—MPI-1. Technical Report NTS-1006. C. R. Lund, Sr., and C. D. McKnight, Jr. (Reynolds Electrical and Engineering Co., Inc. Health and Safety Div., Mercury, Nev.). July 1963. Contract AT(29-2)-162. 18p.

A device was designed for the safe and effective utilization of certain high intensity gamma emitters. A manual of operation, procedures, and applications is presented. (auth)

3933 (TID-18605) CONCEPTUAL DESIGN STUDY OF A MOBILE GAMMA IRRADIATOR FOR FRUIT PRODUCE. (Associated Nucleonics, Inc., Garden City, N. Y.). May 31, 1962. For Brookhaven National Lab., Upton, N. Y. Contract AT(30-1)-2993. 126p. (AN-138)

Engineering Drawings report available as CAPE-944.

A conceptual design study was made of a mobile irradiator for radiopasteurization of strawberries, grapes, peaches, tomatoes, and lemons. Minimum radiation dose specification for the fruit ranged from 100,000 to 200,000 rads with maximum to minimum dose ratio in the range of 1.5 to 3. Minimum allowable production rates were in the range of 500 to 1000 lb of fruit/hr. The irradiator was required to be mobile, preferably on one truck capable of being put in operation one day after arrival at the site. Preliminary studies compared five types of irradiators, consisting of a single source slab, two package pass design; a double slab, single pass design; a single slab, four pass design; a line source rotary design; and a movable source, movable package design. It was concluded that a Co^{60} irradiator can be built to meet the general requirements for radiopasteurization of fruit. The irradiator can be made mobile and can be mounted on a single trailer. The combined weight of the mobile unit would be 70 to 85 tons depending on the type of irradiator. This unit would require a special license from the State Highway Department. (C.H.)

3934 (Y-1449) PRESSURE INTENSIFICATION PROVIDED BY EXTERNAL PRESSURE ON A CYLINDER COMPOSED OF FOUR ANVILS. R. L. Huddleston (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). June 10, 1963. Contract W-7405-eng-26. 117p.

An experimental investigation was made to determine the pressure intensification provided by, and the maximum stresses in, a system of anvils to be used in a pressure intensifier. Seven radial section models and one longitudinal section model were studied. Anvil sizes ranged from 7.25 to 10.25 inches outside diameter. The results of the study indicated a need for several design changes to improve intensification and to reduce stress concentrations. The anvils were redesigned accordingly. (auth)

3935 GENERAL DESIGN OF HIGH-CAPACITY MIXER-SETTLERS. PART 2. C. Hanson (Bradford Inst. of Tech., Eng.). Chem. Process Eng., 44: 651-4 (Nov. 1963).

The results of an investigation of the hydraulic characteristics of vertical and horizontal mixer-settlers previously described are presented. (D.C.W.)

3936 DEVELOPMENT OF A HIGH PRESSURE BLOWER. N. Adorni and L. Cravarola (Laboratori CISE, Milan). Energia Nucl. (Milan), 10: 548-62(Oct. 1963).

The design and the construction of a centrifugal blower for gas circulation in a pressurized loop are described. The design specifications were the following: gas, argon; intake gas pressure, 20.0 kg/cm^2; intake gas temperature, 20°C; head, 4.0 kg/cm^2; capacity, 45.0 m^3/h at 20°C and 22 kg/cm^2 corresponding to 0.452 kg/s; and maximum allowed leakage, 1,000 NTP cm^3/h. Operation tests gave the following results near the maximum efficiency point: rotational speed, 8,100 rpm; head, 4.2 kg/cm^2; capacity, 0.55 kg/s; adiabatic efficiency, 61%; overall efficiency, 51%; power supplied by the motor, 12.8 kW; and leakage, much lower than the maximum allowed leakage. (auth)

3937 A COMBINED PALLADIUM VALVE. Zoltan Madarasz and Zoltan Szabo. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 421-3(1963). (In Hungarian)

A deuterium generator combined with a palladium valve is described that enables the passage of gas at a rate of 50 cm^3/hour for 7.3 w heating power. (auth)

3938 PRESSURE VESSEL DESIGN: NUCLEAR AND CHEMICAL APPLICATIONS. John F. Harvey. Van Nostrand Nuclear Science Series. Princeton, N. J., D. Van Nostrand Co., Inc., 1963. 287p. $9.75.

Information on pressure vessel design, stresses in pressure vessels, stresses in flat plates, discontinuity stresses in pressure vessels, effects of environment on the physical properties of pressure vessel materials, design-construction features, and economics of pressure vessel design and construction is included. (P.C.H.)

3939 IMPROVEMENTS RELATING TO ELECTRIC CABLES. (to General Electric Co.). British Patent 940,269. Oct. 30, 1963. Priority date Feb. 20, 1959, United States.

An electric cable with a polyethylene insulation of improved corona resistance is patented. The cable consists of an electrical conductor covered with one or more layers of cross-linked polyethylene impregnated with a naphthenic-base hydrocarbon oil. Although polyethylene is soluble in cable oil, cross-linked polyethylene is not. The polyethylene may be in the form of a tape and may be cross-linked chemically or by irradiation. Layers of fibrous material may be interspersed between the polyethylene layers, and the entire cable may have an outer oil-impermeable layer. Manufacture of the cable and the physical properties of the cable are described. (M.P.G.)

3940 IMPROVEMENTS IN METHOD AND APPARATUS FOR PROVIDING SUBSTANTIALLY UNIFORM CHARGED PARTICLE IRRADIATION ACROSS AN OBJECT TO BE IRRADIATED. (to General Electric Co.). British Patent 940,845. Nov. 6, 1963. Priority date June 20, 1960, United States.

A method and apparatus are described for providing substantially uniform charged-particle irradiation across an object, in which a particle beam supplied by some generating means is scanned across a window, the object to be irradiated being placed such that its closest point is a predetermined distance from the window. The nonuniform charged-particle density distribution, being formed in the plane of the window, has two maxima spaced from each other and on opposite sides of the midpoint of the distribution. (R.E.U.)

3941 IMPROVEMENTS IN HEAT EXCHANGERS ADAPTED FOR VAPOUR GENERATION WITH LIQUID METAL AS HEATING FLUID. (to Babcock and Wilcox Co.). British Patent 941,315. Nov. 6, 1963. Priority date Mar. 30, 1959, United States.

A heat exchanger is described which is adapted for vapor generation with liquid metal as heating fluid. The pressure vessel contains an open-topped container with tubes arranged within for the flow of the liquid to be vaporized. Liquid metal conduits are provided leading through the pressure vessel wall to and from the container of the tubes. Drawings of complete specification are given. (R.E.U.)

3942 METHOD OF ADJUSTING THE DOSE RECEIVED BY AN OBJECT WHICH IS IRRADIATED BY CORPUSCULAR OR ELECTROMAGNETIC RADIATION AND MOVED IN RELATION TO THE RADIATION SOURCE. Ari Brynjolfsson (to Atomenergikommissionen). British Patent 941,403. Nov. 13, 1963. Filed June 7, 1962.

The relative velocity between the object and the radiation source is regulated by an apparatus in which the velocity is directly dependent on the source intensity. The apparatus is comprised of an instrument for measuring the intensity and a conveyer which is connected to this instrument by appropriate means. The relative velocity is determined by a schedule which is particular to the object to be irradiated. (R.E.U.)

3943 DETERMINATION OF THE TEMPERATURE OF THE WORKING FLUID IN A STEAM GENERATOR. (to Sulzer Frères, Société Anonyme). British Patent 942,486. Nov. 20, 1963. Priority date Mar. 30, 1960, Switzerland.

Apparatus for measuring indirectly the temperature of the working fluid in a forced-flow once-through steam generator is described. The apparatus consists of a means for measuring with low inertia at least one temperature-dependent variable quantity of the working fluid and means for delivering a signal derived from the measurement or measurements and representing the temperature. The variable quantities may be, for example, the density of pressure, or the pressure and viscosity, of the working fluid. (M.C.G.)

3944 IMPROVEMENTS IN OR RELATING TO HIGH-ACTIVITY CELLS. Georges Bonnet and Jean Petit (to Commissariat a l'Energie Atomique). British Patent 942,954. Nov. 27, 1963. Priority date Sept. 3, 1959, France.

Glasses containing stabilizer ions (cerium, for instance) have good resistance to radiation discoloration and a tendency to recover their optical properties if the radiation is reduced below an intensity threshold level. Permanent vision through hot cell windows can be maintained by providing the windows with two connected glass slabs that can alternately be moved behind radiation screens to recover their properties. (D.C.W.)

3945 IMPROVEMENTS IN OR RELATING TO TUBE JOINTS. Peter Munro Boocock and Noel Arthur Clifford Bromidge (to United Kingdom Atomic Energy Authority). British Patent 943,130. Nov. 27, 1963. Filed Aug. 31, 1961.

A technique for joining tubes of different sizes and thermal expansion coefficients is described. Bolts through an annular section secured within the larger tube by internal threads press axially against an annular thermal expansion compensating ring which, in turn bears against an external flange on the smaller tube, pushing it against an internal flange on the larger tube. A gasket is interposed between the flanges. (D.C.W.)

3946 DEVICE FOR FILLING OR EMPTYING SMALL RECEPTACLES FOR LIQUIDS WHICH MUST NOT COME INTO CONTACT WITH THE ATMOSPHERE. Jean Savouyaud and Jean Vertut (to Commissariat à l'Energie Atomique). British Patent 943,453. Priority date Jan. 20, 1961, France.

A device for handling receptacles with stoppers that are self-sealing after being pierced is described. Two hollow needles are used. One is arranged for coupling to a circuit for aspirating gas in the receptacle; the other is set up for connection to a circuit supplying fluid. Provisions are made to prevent entry of the liquid into the aspiration circuit and to rinse the stopper top after withdrawal of the needle. (D.C.W.)

3947 WINDOW ASSEMBLY FOR HIGH ACTIVITY CELLS AND THE LIKE. Georges Bonnet and Jean Petit (to Commissariat à l'Énergie Atomique). Canadian Patent 660,181. Mar. 26, 1963. Priority date Sept. 3, 1959, France.

A window assembly is designed which is based on the auto-regeneration property, i.e., the recovery of the optical characteristics of the glass. The window assembly comprises two identical glass slabs assembled in edge-to-edge relation, a screen located adjacent to the aperture in the wall, and means for reciprocating the glass slab assembly so that the slab which was previously superimposed over the aperture is screened for regeneration and the other slab, previously screened, covers the aperture. Heating means may be used to accelerate the regeneration of the slab behind the screen. (D.L.C.)

3948 PROCESS OF OPERATION OF AND WINDOW FOR A HIGH-ACTIVITY CELL. Georges Bonnet and Jean Petit (to Commissariat à l'Énergie Atomique). Canadian Patent 660,182. Mar. 26, 1963. Priority date Sept. 3, 1959, France.

A window for hot cells is designed which can be manipulated so as to irradiate the two faces successively, allowing one face to regenerate (recover its optical properties) while the other face is being irradiated. The window comprises a movable glass slab supported in a pivoting frame in front of several fixed slabs. The mechanism for pivoting the movable slabs to reverse sides is described in detail. (D.L.C.)

3949 HEAD FOR REMOTE MANIPULATORS. Pierre Pesenti (to Commissariat a l'Energie Atomique). U. S. Patent 3,111,230. Nov. 19, 1963. Priority date Aug. 31, 1959, France.

A knuckle-joint head for a manipulator of radioactive materials is described. In the housing of the head a pivot pin supports a rotatable tubular element that contains a drive member and a roller-guided cable which extends to the drive member. The head is so arranged as to maintain constant cable tension. The drive member is a manually actuable control member. (R.E.U.)

3950 VIBRATION DAMPING AND SHOCK MOUNT. D. J. Stevens and G. W. Forman (to U. S. Atomic Energy Commission). U. S. Patent 3,113,755. Dec. 10, 1963.

A shock absorbing mount in which vibrations are damped by an interference fit between relatively movable parts of the mount is described. A pair of generally cup-shaped parts or members have skirt portions disposed in an oppositely facing nesting relationship with the skirt of one member frictionally engaging the skirt of the other. The outermost skirt may be slotted to provide spring-like segments which embrace the inner skirt for effecting the interference fit. Belleville washers between the members provide yieldable support for a load carried by the mount. When a resonant frequency of vibration forces acting upon the mount attains a certain level the kinetic energy of these forces is absorbed by sliding friction between the parts. (AEC)

Heat Transfer and Fluid Flow

3951 (BNL-6876) SIMULTANEOUS RADIATIVE AND CONVECTIVE HEAT TRANSFER IN AN ABSORBING, EMITTING, AND SCATTERING MEDIUM IN SLUG FLOW BETWEEN PARALLEL PLATES. John C. Chen (Brookhaven National Lab., Upton, N. Y.). Mar. 18, 1963. Contract AT-30-2-GEN-16. 27p.

The problem of coupled radiation and convection to a medium in slug flow between infinite, parallel plates was formulated in terms of discrete fluxes. Steady state, uniform heat input, and gray boundaries were assumed. The effects of absorption, emission, scattering, and flow were taken into account. For the general case where all these effects are present, it was necessary to approximate the fourth order temperature term by a truncated Taylor series. This approximation was not necessary for the special case where conductivity of the medium is negligible. Approximate, analytical solutions in closed-form for profiles of temperature, radiant fluxes, and heat fluxes were obtained for both the special case and the general case. Sample results are presented, showing the effects of convection, absolute temperature, absorption coefficient, scattering coefficient, and wall emissivities. The two cases of equal wall temperatures and unequal wall temperatures were both examined. It was found that for a fluid with the thermal conductivity of air, radiation can account for 60 to 95% of total heat transfer in the temperature range of 900 to 2800°R. It was also found that for some situations, the scattering phenomenon can have a much greater effect on heat transfer than the absorption and emission phenomena. (auth)

3952 (DP-857) FORCED-FLOW BOILING IN ROD BUNDLES AT HIGH PRESSURE. Bruce Matzner (Columbia Univ., New York) and John S. Neill (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). Sept. 1963. Contract AT(30-3)-187. 44p.

The thermal and hydraulic characteristics of electrically heated 7- and 19-rod bundles cooled by forced flow of water with bulk boiling at 1000 psia were measured. The ranges of the variables investigated were: heat fluxes as high as 550,000 pcu/(hr)(ft^2), exit steam qualities as high as 59%, mass velocities from 500,000 to 2,000,000 lb/(hr)(ft^2), and heated lengths of 3 and 6 ft. The power of the test sections was as high as 3.35 megawatts. The sudden deterioration in heat transfer (incipient burnout), as the heat flux or the quality was increased, was detected by thermocouples against the heater wall and by the changes in electrical resistance of the rods. Operation at progressively higher surface temperatures beyond the point of incipient burnout was explored. The effect on heat transfer and pressure drop of spirally wrapped wires, which were used for spacing the rods, was observed. The pressure drops in two-phase flow were correlated. (auth)

3953 (EURAEC-181) STATISTICAL METHODS FOR HOT CHANNEL AND HOT SPOT CALCULATION. Progress Report No. 2, April–June 1961. (FIAT. Sezione Energia Nucleare, Turin). Work performed under United States–Euratom Joint Research and Development Program. Contract 035-60-11 RDI. 23p. (FN-E-8)

The definition and critical analysis of the correction factors, statistical aspects for each subfactor and methods for combining random variables, and the analysis of nuclear and engineering subfactors are discussed. (P.C.H.)

3954 (KAPL-2290) HYDRODYNAMIC STABILITY OF A BOILING CHANNEL. PART 3. A. B. Jones and D. G. Dight (Knolls Atomic Power Lab., Schenectady, N. Y.). June 28, 1963. Contract W-31-109-eng-52. 125p.

An extension is made of previous analytical work on the problem of predicting the degree of hydrodynamic stability of a single heated channel across which a constant pressure drop is imposed. The extension concerns the formulation of an explicit model to account for the existence of subcooled boiling, which was essentially ignored in the previous analysis. A computer program (STABLE-4) for the revised analysis is described, and preliminary results are discussed. (auth)

3955 (NP-13319) CAVITATION DAMAGE IN MERCURY AND WATER IN A CAVITATING VENTURI AND OTHER COMPONENTS. Technical Report No. 9. F. G. Hammitt, L. L. Barinka, V. A. Biss, R. D. Ivany, R. D. Pehlke, M. J. Robinson, and C. A. Siebert (Michigan. Univ., Ann Arbor. Coll. of Engineering). Sept. 1963. 479p. (ORA-03424-9-T)

Comprehensive detailed data are presented principally on cavitation tests of specimens of various materials of interest inserted into a cavitating venturi. Fluids used are mercury and water. Since the water data were previously reported, emphasis is on the mercury results, but comparisons are made with water wherever possible. Hypotheses for damage mechanisms are presented and discussed in light of the experimental observations. In addition to the cavitating venturi experiments, damage results in both fluids on various other flow components are presented and discussed. (auth)

3956 (TID-18385) HEAT TRANSFER IN A RADIATING FLUID WITH SLUG FLOW IN A PARALLEL-PLATE

CHANNEL. R. Viskanta (Argonne National Lab., Ill.). Nov. 1962. Contract W-31-109-eng-38. 34p. (UAC-7181)

Fully developed heat transfer in slug flow in a flat duct between two parallel plates was studied. The flat duct consists of two diffuse, nonblack, isothermal surfaces. The gray radiating fluid between them is capable of emitting and absorbing thermal radiation. The problem was formulated in terms of a nonlinear integrodifferential equation, and the solution was obtained by an approximate method. The differences between heating and cooling the fluid were examined. The effects of the optical thickness of the fluid, the ratio that determines the relative role of energy transport by conduction to that by radiation, and the emissivity of the duct surfaces on the temperature distribution and the heat transfer characteristics were investigated. An approximate method for calculating the radiant heat flux at the wall is presented, and the accuracy of the approximation was tested. (P.C.H.)

3957 (TID-19477) AN EXPERIMENTAL STUDY OF PARTICLE-FLUID HEAT TRANSFER IN A WATER FLUIDIZED SYSTEM (thesis). Tomlin Walter Moore (Southern Methodist Univ., Dallas). Aug. 30, 1963. Contract AT (30-1)-2751. 105p.

Particle-fluid heat transfer rates in a water fluidized system were studied. Steel and lead particles were heated with an induction heater to simulate internal heat generation, which would be experienced in a fluidized nuclear reactor. The experimental heat transfer coefficients were calculated using a transient cooling technique dependent upon the temperature distribution of the water in the fluidized bed. Two proposed water temperature distributions were used in making the calculations, and the results obtained from the two distributions were compared. The experimental data were correlated in terms of dimensionless groups, and compared with the results of previous investigations of particle-fluid heat transfer rates. A detailed analysis of the factors that appeared to be influential in developing particle-fluid heat transfer correlations showed that the data could be correlated with an equation of the form $Nu = C(ReF_\epsilon)^a Pr^b (D_T/D_p)^{.5} (\rho_f/\rho_p)^d$ where a, b, C, and d were experimentally determined constants. (auth)

3958 LAMINAR FLOW OF A HEAT-GENERATING FLUID IN A PARALLEL-PLATE CHANNEL. E. M. Sparrow, J. L. Novotny, and S. H. Lin (Univ. of Minnesota, Minneapolis). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 9: 797-804(Nov. 1963).

An analysis of heat-generating laminar flow in a parallel-plate channel including both prescribed wall temperature and prescribed wall heat flux was carried out for both the thermal entrance region and the fully developed region. Consideration was given not only to the basic cases of uniform wall temperature and uniform wall heat flux but also to arbitrary longitudinal distributions of the wall temperature or wall heat flux. The internal heat generation in the fluid may also have arbitrary longitudinal and transverse variations. (P.C.H.)

3959 THE DISPERSION OF GAS DURING TURBULENT FLOW IN A PIPE. C. G. Clayton, J. W. Webb, and J. B. Whittaker (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Brit. J. Appl. Phys., 14: 790-4 (Nov. 1963).

An expression for the dispersion of a compressible fluid in turbulent motion in a pipe was derived. The solution is based on Taylor's theory for dispersion during incompressible fluid flow but allows for the continuous increase in linear velocity which can occur during turbulent flow of a compressible fluid. The theory was checked experimentally by injecting radioactive Kr^{85} into air flowing turbulently in a smooth pipe. The width 2S of the tracer at distance L along a pipe of diameter 2α and Fanning friction factor γ is shown to be given by the equation

$$S^2 = 3.24 \times 10^8 \gamma^{0.96} \left(\frac{L}{a}\right)^{0.135} La \frac{U_L}{U_0}$$

where U_L/U_0 is the ratio of the mean velocities of flow at the point of measurement and at the point of injection. The equation is compared with that predicted theoretically which is of the form $S^2 = F\gamma^{0.5}\ La(U_L/U_0)$ where F is a constant. (auth)

3960 CONTROL PRINCIPLES OF NUCLEAR BOILERS. F. L. Carvalho. Chem. Process Eng., 44: 648-50; 654(Nov. 1963).

The broad outline of the approach to control system design for nuclear power plants, and more specifically the control of two classes of boilers generally incorporated in reactor systems, drum-type units and once-through units, are described. Some safety aspects concerning control are also considered. (auth)

3961 DENSITY MEASUREMENTS IN A BOILING CHANNEL. V. E. Schrock (Univ. of California, Berkeley), G. Angelino, G. Possa, and J. B. Van Erp. Energia Nucl. (Milan), 10: 525-35(Oct. 1963).

Preliminary results are presented for an experimental program concerning the measurement of total void and mean density in a water-cooled boiling channel. Use is made of a dilatation technique. Experimental data cover the following preliminary static test conditions: specific flow rate, 27 g/cm²s; pressure, 9-11-13 kg/cm²; inlet quality, $-8\% < X_i < +2\%$; and exit quality, $0\% < X_0 < 50\%$. (auth)

3962 NON-NEWTONIAN SUSPENSIONS. PART II. TURBULENT TRANSPORT CHARACTERISTICS. David G. Thomas (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., 55: No. 12, 27-35(Dec. 1963).

The suspensions were prepared from symmetrically shaped particles of micron-size metal oxides. The turbulent transport characteristics of these suspensions used in laminar-flow studies are shown to be unique functions of the intrinsic and extrinsic physical properties of the suspension independent of the composition of the solid phase. Turbulent friction losses of suspensions of titania, kaolin, and thorium oxide were analyzed. Heat transfer to flocculated suspensions was investigated and heat- and momentum-transfer analogies are discussed. Nucleate boiling heat-transfer measurements were made with aqueous ThO_2 suspensions containing fraction solids. Concentrated- and dilute-suspension transport is discussed in terms of the yield stress effects on minimum transport velocity. (R.E.U.)

3963 TRANSIENT NATURAL CONVECTION FOR VERTICAL ELEMENTS FOR TIME DEPENDENT INTERNAL ENERGY GENERATION—APPRECIABLE THERMAL CAPACITY. B. Gebhart (Cornell Univ., Ithaca, N. Y.). Intern. J. Heat Mass Transfer, 6: 951-7(Nov. 1963).

Temperature response was determined for natural convection transients involving an element of finite thermal capacity (in an extensive fluid) subject to a linear increase in input thermal energy to an asymptotic value. Response characteristics were obtained by numerically integrating the differential equations that resulted from a modified integral analysis of such transients. The calculations indicate the nature of transient response and indicate the conditions under which such transients may be accurately treated as quasi-static processes. (auth)

3964 THE MECHANISM OF NUCLEATE BOILING HEAT TRANSFER. T. Hara (Railway Technical Research Inst., Tokyo). Intern. J. Heat Mass Transfer, 6: 959-69(Nov. 1963).

In nucleate boiling a bubble created at nucleation site on a heating surface grows, leaves the surface, and rises. The fluid motion induced in the thermal boundary layer during the process is calculated and the heat flux carried by this liquid motion to a nucleation site is obtained. The heat flux thus calculated is equal to that transferred from the heating surface to the liquid by conduction and to the latent heat carried away by the bubble per unit time. From these relations the following theoretical formula is obtained. $\Delta\theta = 0.114\, n^{-1/4} q^{1/2}$ where $\Delta\theta$ is a temperature difference between the temperature of heating surface and the saturation temperature, n is the number of nucleation sites per unit area, and q is average heat flux. (P.C.H.)

3965 ACOUSTICAL OSCILLATION IN STEAM SYSTEMS. H. Christensen (Institutt for Atomenergi, Kjeller, Norway). Nukleonik, 5: 279-85(Oct. 1963).

A theoretical description of acoustical oscillations in steam systems is given. Topics covered include: fundamental equations, electrical transmission line, analogy between electrical and steam lines, lumped-parameter reactor system, distributed parameter system, and improved lumped-parameter solution. Numerical results are given. (M.C.G.)

3966 SOME DISCUSSIONS ON BURNOUT OF FUEL ELEMENT COOLED BY NATURAL CIRCULATION. Itaru Michiyoshi. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 10: No. 10, 141-61(Dec. 1960).

The mechanics of flow related to a physical system having inertia, resistance to flow, energy storage in water and steam, and driving force due to density head, especially in natural circulation in boiling water reactors, is discussed. Special emphasis is placed on the change in flow-appearance until burnout of a given annulus. Surface boiling, which can cause both burnout in a wide annulus and flow instability in a narrow annulus, is discussed. (R.E.U.)

3967 EXPERIMENTAL STUDIES ON TRANSIENT BOILING. Takashi Sato, Itaru Michiyoshi and Kiichiro Takeuchi. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 12: No. 8, 107-20(Sept. 1962).

The meltdown caused by step-input to a fine Nichrome wire that is vertically supported at the center of a glass pipe is considered. The effects of tube diameter and air content in water are investigated, especially in relation to the burnout. The experiments were carried out under natural circulation of water of 80°C subcooling at atmospheric pressure, and the behavior of the bubbles and its effect on the burnout are discussed. (auth)

3968 SUBCOOLING DETECTOR. J. A. McCann (to U. S. Atomic Energy Commission). U. S. Patent 3,114,263. Dec. 17, 1963.

A system for detecting and measuring directly the subcooling margin in a liquid bulk coolant is described. A thermocouple sensor is electrically heated, and a small amount of nearly stagnant bulk coolant is heated to the boiling point by this heated thermocouple. The sequential measurement of the original ambient temperature, zeroing out this ambient temperature, and then measuring the boiling temperature of the coolant permits direct determination of the subcooling margin of the ambient liquid. (AEC)

Materials Testing

3969 (ORNL-3470(p.94-7)) NONDESTRUCTIVE TEST DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Nondestructive techniques are under continuous development for testing nuclear components, particularly by use of electromagnetic, ultrasonic, and penetrating radiation. A new phase-sensitive eddy-current instrument, operating in the frequency range 1 kc to 4 Mc, has greater applicability to thickness measurements than more conventional instruments. A mathematical model to aid design of improved electromagnetic probes is being programmed. Ultrasonic studies have led to development of a new device for inspecting brazed heat-exchanger joints. Low-voltage radiography was extended to contact radiography capable of 500× magnification and useful for evaluating coated uranium carbide particles. Improved gamma- and x-ray transmission techniques are being developed for the determination of fuel-loading variations in fuel plates and rods. Existing test methods are being adapted to measurements of problem materials and measurements in radiation fields. (auth)

Protective Structures

3970 (AD-299189(Suppl.1)) PROTECTIVE CONSTRUCTION. A Report Bibliography. (Defense Documentation Center, Arlington, Va.). Mar. 1963. 9p.

A selected list of 30 references related to the construction of strategic military facilities to resist either nuclear or conventional explosives is presented. Entries include references to reports pertaining to characteristics of nuclear explosions, propagation of shock waves, underground explosions, soil mechanisms, and response of structures to blast. (C.H.)

3971 (WT-1723) RADIATION SHIELDING AND RESPONSE STUDIES OF AEC TEST STRUCTURES. R. A. Cameron, Jr., and P. H. Huff (Holmes and Narver, Inc., Los Angeles). June 1962. Project 34.2 of OPERATION HARDTACK, April–October 1958. 57p.

The variation of the radiation dose in different positions inside four small shallow-buried reinforced-concrete test structures are determined, and the accelerations inside two of these structures are compared with the accelerations in the adjacent free field. Film badges, chemical dosimeters, and energy-dependent film badges are placed throughout all four of the structures. In addition, in two of the structures, a self-recording accelerometer is located in a corner on the floor. Two more accelerometers of the same type are located in the ground about 20 ft from the two stations. Even for the small structures considered in this test, considerable variation is observed in the radiation dose for various locations in the structures. The average radiation readings in the structures are higher by a factor of about 3 than those predicted. The energy-dependent film badges, which also are strongly direction-dependent, indicate that the radiation near the bottom of the structures is approximately isotropically distributed. However, calculated doses at individual badge locations based on the isotropic distribution do not agree well with observed doses. In all cases the peak accelerations recorded inside the shelters are higher than the corresponding free-field peaks. Consequently it is suggested that predicted free-field peak motions (acceleration, velocity, and displacement) be multiplied by 1.5 to predict the corresponding peaks inside structures similar to those observed in this test. (auth)

3972 FOLDABLE FALLOUT SHELTER. Robert S. Forbes. Canadian Patent 664,597. June 11, 1963. Filed Feb. 2, 1962.

An easily erectible and collapsible tent-like structure is designed which includes a floor and may be adapted for use either outside or inside. The erecting mechanism may

be mechanical or hydraulic and is independent of external power sources. (D.L.C.)

Vacuum Engineering

3973 VACUUM EVAPORATOR FOR ULTRA-HIGH VACUUM FABRICATION OF MULTILAYER DEVICES. Hollis L. Caswell (IBM Corp., Yorktown Heights, N. Y.). 14p. (CONF-209-10)

From American Vacuum Society Meeting, Boston, Oct. 1963.

An evaporator was built for use in a bakeable, oil-free, ultra-high vacuum chamber which permits multilayer thin-film devices of three metals and one dielectric to be made. Problems due to high friction in the clean chamber are circumvented through the use of bellows that allow movement and registration fixtures to be exterior to the vacuum chamber. These fixtures may be removed during baking and lubricated while in use. Currently, four substrates ($^3/_4$" × $^3/_4$") and four different evaporation masks are being used. However, with smaller substrates, additional masks may be employed. Cross contamination of evaporation sources is minimized through the use of removable covers and evaporation rates are controlled with an ionization gage monitor. Results on trapped flux in lead films obtained on devices fabricated in this system are also discussed. (auth)

GEOLOGY AND MINERALOGY

General

3974 (NYO-10517(p.149-52)) A COMPUTER PROGRAM TO CALCULATE A LEAST SQUARES ISOCHRON AND ASSOCIATED ERRORS. R. M. Shields (Massachusetts Inst. of Tech., Cambridge).

A program that computes a least squares isochron plot following the method presented by Youden is described. The program, in FORTRAN II, calculates all K factors, Rb^{87}/Sr^{86} atomic ratios, slopes, intercepts, ages, and associated errors. (D.C.W.)

3975 (ORNL-TM-713) GEOLOGIC MAP OF THE OAK RIDGE RESERVATION, TENNESSEE. William M. McMaster (Oak Ridge National Lab., Tenn.). Nov. 22, 1963. Contract W-7405-eng-26. 42p.

The Oak Ridge area is underlain by nine Paleozoic sedimentary formations or groups ranging in age from Early Cambrian to Early Mississippian. These units consist mostly of dolomite, limestone, and shale. The Conasauga Group, the Knox Group, and the Chickamauga Limestone can be further subdivided. The Oak Ridge reservation is crossed by two major thrust faults, the Copper Creek fault in the southeastern part of the area and the Whiteoak Mountain fault in the northwestern part. The strata and the fault zones dip primarily to the southeast. The Whiteoak Mountain fault in the Oak Ridge area exhibits several subsidiary features, including branch faults, a syncline northwest of the fault, and two slices of dolomite of the Knox Group. (auth)

3976 (TID-19743) FINAL DEVELOPMENT OF ISOTOPE TECHNIQUES FOR RELOCATION OF LAND MONUMENTS. Robert P. Petersen (Entech Corp., Des Plaines, Ill.). Sept. 1963. Contract AT(11-1)-1278. 42p.

The use of radioactive tracers as a means of marking a land monument was investigated. The present study attempted to demonstrate the engineering practicability of marking with radioisotopes and to test the validity of using stable radioisotopes detected by neutron generators. Requirements for practicability led to the conclusion that for the particular application of interest to the Bureau of Land Management, there does not appear to be a useful method. A method using electromagnetic radiation of radio wave lengths is recommended. (H.M.G.)

3977 COLUMBIUM AND TANTALUM MINERALS, ORES, AND ORE PREPARATION. John M. Warde, Virginia A. Mee, and H. R. Spedden. p.1-29 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

Nb and Ta are generally found in mineral deposits of complex oxides, especially in the columbite–tantalite and pyrochlore–microlite series of minerals. The composition of these minerals and the geology of Nb and Ta deposits are discussed. Pyrochlore-bearing carbonatites under development throughout the world and world production and resources of Nb and Ta are tabulated. Methods of mining and beneficiation of the minerals are described. Flow sheets for plants employing gravity concentration and magnetic and electrostatic separation and a table of the composition of typical commercial concentrates are included. (M.P.G.)

Natural Radioactivity and Fallout

3978 (HNS-1229-22) PRODUCTION OF LONG-LIVED FISSION PRODUCTS AND THERMAL NEUTRON-INDUCED RADIONUCLIDES IN UNDERGROUND NUCLEAR EXPLOSIONS. C. L. Carnahan and P. Kruger (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Mar. 1, 1963. Contract AT(29-2)-1229. 26p.

Calculations of initial radioactivity levels were made for long-lived radionuclides produced by fission and thermal neutron activation of the surrounding geologic media resulting from underground nuclear explosions. Since the transport of ground water contaminated with radionuclides is small over short periods of time but may be expected to exist for indefinite time, all radioactive nuclides are considered that have half lives greater than 0.5 year. Contamination of surface water in the vicinity of a nuclear explosion is not treated. Discussions of the limitations of these calculations also are given. (auth)

3979 (NYO-10517) VARIATIONS IN ISOTOPIC ABUNDANCES OF STRONTIUM, CALCIUM, AND ARGON AND RELATED TOPICS. Eleventh Annual Progress Report for 1963. (Massachusetts Inst. of Tech., Cambridge). Dec. 1, 1963. Contract AT(30-1)-1381. 152p.

Separate abstracts were prepared for twenty-eight of the thirty-three papers. The other papers deal with whole-rock Rb–Sr ages of Ontario norite and micropegmatite and the Southern Rhodesia Great Dyke, Sr isotopes in vein type mineral deposits, whole-rock Rb–Sr studies of volcanics, and accuracy in Sr^{87}/Sr^{86} measurements. (D.C.W.)

For abstracts of individual items see: 3678, 3974, 3980, 3981, 3982, 3983, 3984, 3985, 3986, 3987, 3988, 3989, 3990, 3991, 3992, 3993, 3994, 3995, 3996, 3997, 3998, 3999, 4000, 4001, 4057, 4382, 4383, and 4486.

3980 (NYO-10517(p.3-5)) CALCIUM ISOTOPE RATIOS IN THE HOMESTEAD AND PASAMONTE METEORITES AND A DEVONIAN LIMESTONE. Milo M. Backus, W. H. Pinson, L. F. Herzog, and P. M. Hurley (Massachusetts Inst. of Tech., Cambridge).

The results of a replicate analysis of Ca from a terrestrial limestone, a chondrite with a Ca/K ratio of about 11, and an achondrite with a Ca/K ratio of about 150 are presented. For common Ca (Devonian limestone) isotopic abundances, in atom %, of 96.88 ± 0.05, 0.655 ± 0.006, 0.138 ± 0.002, 2.12 ± 0.04, 0.0046 ± 0.0010, and 0.200 ± 0.006 were obtained for Ca^{40}, Ca^{42}, Ca^{43}, Ca^{44}, Ca^{46}, and Ca^{48}, respectively. Ca from the Iowa chondrite was isotopically identical to common calcium to within ±1%, except for a better measurement of the Ca^{46}/Ca^{40} ratio. Ca^{40} in the achondrite may, however, be depleted by up to 3%. (D.C.W.)

3981 (NYO-10517(p.17-22)) PRELIMINARY INVESTIGATION OF Rb^{87}–Sr^{87} RELATIONSHIPS IN THE SIERRA NEVADA PLUTONIC PROVINCE. P. M. Hurley, P. C. Bateman, H. W. Fairbairn, and W. H. Pinson (Massachusetts Inst. of Tech., Cambridge).

One to three whole-rock samples from each of more than a dozen discrete plutonic intrusives in the east-central Sierra Nevada batholith were analyzed for Sr^{87}/Sr^{86} and Rb/Sr ratios. The results indicate a set of isochrons that divide the intrusives into two principal age groups: 130 ± 10 and 92 ± 10 million years. Several intrusives off the isochrons will require individual isochron analysis and may later demonstrate more or less continuous magmatism between the two peaks of activity. The results are generally compatible with field relations. Tentatively, the granodiorite of McMurry Meadows, the Tinemaha and Inconsolable

granodiorites and the Mount Alice pluton of quartz monzonite are in the older group; and the Lamarck and Mount Givens granodiorites and the alaskites of Evolution Basin and Dinkey Lakes are in the younger. The older isochrons show initial Sr^{87}/Sr^{86} ratios of 0.709 ± 0.001, and the younger isochrons 0.707 ± 0.001. These are compatible with the hypothesis that the Sierra Nevada magmas were formed by anatexis in a geosyncline containing much volcanogenic material of fairly recent origin, and some terrigenous sialic detritus. The initial ratios are also compatible with a magmatic derivation from a very ancient basalt. (auth)

3982 (NYO-10517(p.23-5)) INITIAL $Sr^{87}-Sr^{86}$ AND PRELIMINARY WHOLE-ROCK AGE OF GRANITIC ROCKS IN SOUTHERN BRITISH COLUMBIA. H. W. Fairbairn, P. M. Hurley, and W. H. Pinson (Massachusetts Inst. of Tech., Cambridge).

Whole-rock strontium isotopic analysis of ten post-Jurassic granitic rocks from southern British Columbia, selected from about eighty field localities on the basis of low Rb/Sr (< 0.12), gives a range of values of Sr^{87}/Sr^{86} from 0.7054 to 0.7096. As the correction in such rocks (0.0002–0.0003) for initial Sr^{87}/Sr^{86} (zero age) is less than analytical error (0.0005) the final values may be stated approximately as 0.705–0.710. These are higher than the range (0.704–0.705) established for mantle derived oceanic basalt, and Sr^{87} contamination of the granitic magma during emplacement in an orogenic environment is postulated. Isotopic analysis of twelve additional samples, selected on the basis of maximum spread of Rb/Sr (using x-ray spectrograph) gives one isochron of moderate quality ($57 \pm 3 \times 10^6$ yr based on initial $Sr^{87}/Sr^{86} = 0.7063$) from a section of five samples south of Vernon. Combinations of the other plotted analyses, all with different initial Sr^{87}/Sr^{86} but within the range 0.705–0.710, give tentative ages of 52 ± 5, 57 ± 10, and $81 \pm 24 \times 10^6$ yr. Comparison with published K–Ar mica ages in the same general region shows reasonable agreement with these whole-rock numbers and is compatible with an Early Tertiary intrusive period $50-60 \times 10^6$ yr ago and with Late Cretaceous plutonic activity $75-85 \times 10^6$ yr ago. (auth)

3983 (NYO-10517(p.27-38)) VARIATION OF STRONTIUM ISOTOPES IN TEKTITES. C. C. Schnetzler and W. H. Pinson, Jr. (Massachusetts Inst. of Tech., Cambridge).

The rubidium, strontium, and strontium isotopic compositions have been determined in tektites from Indo-China, Philippine Islands, Java, Australia, Texas, Georgia, Massachusetts, and Czechoslovakia. The range of Sr^{87}/Sr^{86} ratios in 18 tektites is from 0.7121 to 0.7223, indicating the results of Pinson, reporting no radiogenic strontium in tektites, were not of sufficient precision to study the problem definitively. This range of Sr^{87}/Sr^{86} ratios is quite small compared to the range found in nature, in general agreement with previous studies of oxygen and silicon isotopes in tektites. Rb and Sr contents of tektites from a given locality are very similar, but differences exist between localities. There is indicated, however, a sympathetic variation of the Sr^{87}/Sr^{86} and Rb/Sr ratios; i.e., the tektite groups have age values of approximately 400×10^6 yr. If tektites were derived from the Moon, and the surface of the Moon is old (4.5×10^9 yr), the observed Sr^{87}/Sr^{86} ratios could not have been developed by a chondritic, granitic, or tektitic surface material, but could have been generated by a basaltic type material. However, production of tektites from a basaltic type surface material during a high temperature fusion implies extreme fractionation in a direction contrary to expectation. A second possibility is that the Moon has undergone differentiation within the last 500×10^6 yr. (auth)

3984 (NYO-10517(p.39-42)) ISOTOPIC COMPOSITION OF MARINE STRONTIUM. G. Faure, P. M. Hurley, and J. L. Powell (Massachusetts Inst. of Tech., Cambridge).

The arithmetic mean of the Sr^{87}/Sr^{86} ratio determined for ten samples of marine strontium from the northern half of the Atlantic Ocean is 0.7093 ± 0.0005, in good agreement with analyses of several other investigators. No regional variations in the abundance of Sr^{87} in ocean water were observed. The average Sr^{87}/Sr^{86} ratio of ocean water is compared to primary volcanic strontium, thought to be derived from depth in the earth, and "crustal" strontium which has been variously enriched in radiogenic Sr^{87} by decay of Rb^{87}. (auth)

3985 (NYO-10517(p.43-9)) WHOLE ROCK RUBIDIUM STRONTIUM STUDIES IN THE GRENVILLE SUBPROVINCE. T. E. Krogh (Massachusetts Inst. of Tech., Cambridge).

The strontium isotope ratios of granites and Labrador Trough rocks within the Grenville subprovince were determined by mass spectrometry, and Rb^{87}/Sr^{87} values were calculated from x-ray analysis data on samples reduced to fluorides. The results are presented and discussed. (D.C.W.)

3986 (NYO-10517(p.51-2)) ISOTOPIC COMPOSITION OF STRONTIUM IN SOME CARBONATITES AND CARBONATE ROCKS OF UNCERTAIN CLASSIFICATION. J. L. Powell and P. M. Hurley (Oberlin Coll., Ohio and Massachusetts Inst. of Tech., Cambridge).

The criterion that the Sr^{87}/Sr^{86} ratios of all the carbonatites that were previously analyzed were lower than those of most limestones was applied to some carbonate rocks, the classification of which was difficult on the basis of field evidence. Several possible carbonatites from regions that may be new carbonatite provinces were also considered. (D.C.W.)

3987 (NYO-10517(p.53-4)) PRELIMINARY AGE STUDY OF THE DEDHAM GRANITIC ROCKS. Alan Ramo and H. W. Fairbairn (Massachusetts Inst. of Tech., Cambridge).

The Rb–Sr whole rock method was used in a preliminary age study of the granitic area south of Boston. Samples from the Hoppin Hill area and the main Dedham body to the north were subjected to isotopic analysis of Sr^{87}/Sr^{86} and x-ray determination of Rb/Sr. The Dedham isochron indicates an age of $(558 \pm 20) \times 10^6$ yr, while the combined isochron gives $(522 \pm 6) \times 10^6$ yr. Evidence that the Rb/Sr x-ray ratios are systematically low indicates that the ages may be nearer to 500×10^6 yr. (D.C.W.)

3988 (NYO-10517(p.55-64)) THE PROBLEM OF INHERITED RADIOGENIC STRONTIUM IN SEDIMENTARY AGE DETERMINATIONS. P. R. Whitney and P. M. Hurley (Massachusetts Inst. of Tech., Cambridge).

The extent to which the presence of inherited radiogenic Sr in the detrital minerals affects the accuracy of Rb/Sr whole-rock age determinations on shale was investigated. Rb and Sr in shale samples from the Hamilton Group (Middle Devonian) of New York and Pennsylvania were measured by stable isotope dilution methods, and Sr isotope ratios were obtained by mass spectrometry. An apparent isochron age of $(398 \pm 12) \times 10^6$ yrs was obtained, not more than 15% in excess of the actual age of Middle Devonian as estimated from published data on igneous and metamorphic rocks. Whole-rock Rb/Sr chronology is recommended for ancient unfossiliferous sediments. (48 references). (D.C.W.)

3989 (NYO-10517(p.65-84)) WHOLE-ROCK Rb–Sr STUDIES OF VOLCANICS AND SOME RELATED GRANITES. M. L. Bottino (Massachusetts Inst. of Tech., Cambridge).

A series of geologically dated volcanic rocks from the northern Appalachians were analyzed for their Rb, Sr, and Sr isotopic composition. For each suite a series of whole-rock samples with different Rb–Sr ratios were analyzed and an isochron constructed. Satisfactory isochrons were obtained for most areas studied. The age results are internally consistent and do not contradict field evidence. The ages derived are approximately 8% lower than the recent time scale estimates for the Silurian and Devonian. The discrepancy apparently increases in the Pennsylvanian. In the areas studied the ages overlap the published biotite ages from intrusives in the section, suggesting a rapid sequence of sedimentation, burial, and intrusion. A series of isochrons for the Cape Ann granite, the Quincy granite, and the Blue Hills porphyry and aporhyolite yield three different ages for the alkaline granites and rhyolite, all of which had previously been correlated and considered contemporaneous. These results extend the alkaline igneous activity in New England back to the Ordovician and Silurian. The initial ratios determined from the isochrons show that four of the eight granites and rhyokites crystallized with Sr^{87}/Sr^{86} ratios well above the value for basaltic rocks. This is interpreted as indicating that these rocks are partially or wholly of crustal origin. Six basalts a rhombenporphyry, and four rhyolite and granite isochrons gave initial ratios in the basaltic range. (58 references). (auth)

3990 (NYO-10517(p.85-95)) Rb–Sr GEOCHRONOLOGICAL INVESTIGATION IN THE MIDDLE HADDAM AND GLASTONBURY QUADRANGLES, EASTERN CONNECTICUT. D. G. Brookins (Kansas State Univ., Manhattan) and P. M. Hurley (Massachusetts Inst. of Tech., Cambridge).

Some of the Pre-Triassic rocks of the Middle Haddam and Glastonbury quadrangles in Eastern Connecticut were investigated by the whole-rock Rb–Sr method of age determination to aid interpretation of the complex problems of stratigraphy and correlation within the area. Whole-rock ages are reported for the Maromas Granite Gneiss, the Glastonbury Gneiss, the Middletown Formation, the Collins Hill Formation, and the Monson Gneiss. In addition, the Ammonoosuc volcanics of New Hampshire were studied by the whole-rock method to test its proposed correlation with the Middletown formation. The Collins Hill Formation yields a possible age of $(390 \pm 40) \times 10^6$ yr, with an initial ratio of 0.718 ± 0.003; but the isochron is poorly defined due to scatter of points. Granitic dikes which cut the Monson Gneiss yield a maximum age of $(418 \pm 15) \times 10^6$ yr. The proximity in age between the Middletown Formation and the Ammonoosuc Volcanics tentatively confirms their correlation. The different ages for the granitic dikes in the Monson, the Glastonbury, and the Maromas indicate several periods of emplacement of granitic material within the area. The pegmatites are probably not directly related to any of the granitic gneisses in the area because of their high initial ratio of about 0.735. (auth)

3991 (NYO-10517(p.99-103)) CORRELATION OF STRONTIUM ISOTOPE ABUNDANCES WITH SILICA CONTENT OF HAWAIIAN LAVAS. J. L. Powell, G. Faure, and P. M. Hurley (Ohio State Univ., Columbus; Oberlin Coll., Ohio; and Massachusetts Inst. of Tech., Cambridge).

Chemical analyses and Sr^{87}/Sr^{86} and Rb/Sr ratio measurements on the lavas indicate a positive correlation between their silica contents and their Sr^{87}/Sr^{86} ratios. It is concluded that there may be at least two sources within the upper mantle from which Hawaiian magmas are derived. The data also support the view that the more undersaturated volcanic rocks are derived from greater depths than the alkaline olivine basalts and tholeiites. (D.C.W.)

3992 (NYO-10517(p.105-10)) INITIAL $Sr^{87}-Sr^{86}$ WHOLE-ROCK AGE, AND DISCORDANT BIOTITE IN THE MONTEREGIAN IGNEOUS PROVINCE, QUEBEC. H. W. Fairbairn, G. Faure, W. H. Pinson, P. M. Hurley, and J. L. Powell (Massachusetts Inst. of Tech., Cambridge).

Rb–Sr isotopic analyses of sixteen whole-rock samples from ten localities in the Monteregian igneous province, Quebec, show that the initial Sr^{87}/Sr^{86} is 0.7040 ± 0.0002, thus agreeing with the current estimate for alkaline oceanic basalt. An isochron plot of nordmarkite and essexite from adjoining localities, Brome and Shefford, gives $(Sr^{87}/Sr^{86})_0 = 0.7039$ and an age of 124×10^6 yr (early Cretaceous). The former agrees with the overall estimate; the latter is in approximate agreement with four of five K–Ar biotite ages, but is significantly higher than five Rb–Sr biotite analyses. A radiogenic Sr^{87} development plot of biotites and whole-rocks from Brome shows that the biotites from the comagmatic nordmarkite and essexite have comparable ages (84.4 and 88.3×10^6 yr, respectively), thus indicating a post-crystallization Sr diffusion episode in late Cretaceous. (auth)

3993 (NYO-10517(p.111)) Rb–Sr RELATIONSHIPS IN PUERTO RICO SERPENTINITE AND ST. PAUL'S ROCK DUNITE. Progress Report. P. M. Hurley, H. W. Fairbairn, and W. H. Pinson, Jr. (Massachusetts Inst. of Tech., Cambridge).

Whole-rock samples of serpentinite from the AMSOC drill hole in Puerto Rico and of dunite from St. Paul's rock were analyzed for the ratio Sr^{87}/Sr^{86}, along with a standard sample of $SrCO_3$. The results show that the Sr in the rocks is not derived from sea water. The Rb/Sr ratios necessary to give the Sr^{87}/Sr^{86} ratios were also calculated. (D.C.W.)

3994 (NYO-10517(p.113-16)) GEOCHRONOLOGY OF SOME GRANITIC PLUTONS, LAKE OF THE WOODS REGION, ONTARIO. R. A. Heimlich (Kent State Univ., Kent Ohio).

Two composite granitic stocks and the tonalitic portion of a large intrusive complex were emplaced in a Precambrian greenstone sequence composed of steeply dipping metavolcanic rocks and minor metasedimentary rocks. The area is roughly 20 miles east of the village of Sioux Narrows, District of Kenora, Ontario. The available field data suggest that the three bodies were intruded at the same time. Absolute age data, consisting of a Rb–Sr microcline determination and a K–Ar biotite determination from one of the stocks and a K–Ar biotite determination from the tonalite mass, confirm the contemporaneity of the plutons. A clustering of the age determinations between 2480 and 2685 × 10^6 yr indicates that these intrusives may belong to the "Laurentian" group. (auth)

3995 (NYO-10517(p.121-2)) MATRIX EFFECT IN THE MEASUREMENT OF Rb–Sr BY X-RAY SPECTROMETER. Marla Heath (Massachusetts Inst. of Tech., Cambridge).

Discrepancies up to 5% between measurements of Rb/Sr by x-ray spectrometry and isotope dilution have been observed. Absorption edge effects and effects of matrix changes on x-ray spectrometry measurements are considered. (D.C.W.)

3996 (NYO-10517(p.123-4)) A STUDY OF STRONTIUM REDISTRIBUTION UNDER CONTROLLED CONDITIONS OF TEMPERATURE AND PRESSURE. R. H. McNutt and H. Hughes (Massachusetts Inst. of Tech., Cambridge).

The equilibrium redistribution of Sr among coexisting mineral phases under experimentally controlled conditions was investigated. Systems consisting of plagioclase and/or biotite and a spike solution (Sr, Sr^{84}, or Sr^{87}) were heated in a sealed copper jacket. After separation, the liquids and minerals were subjected to mass spectrometric analysis. Equilibrium conditions were not established, probably because the driving forces tending to redistribute the Sr were smaller than in ordinary diffusion experiments. (D.C.W.)

3997 (NYO-10517(p.125-6)) THE ISOTOPIC COMPOSITION OF STRONTIUM IN MAFIC ROCKS. G. Faure (Massachusetts Inst. of Tech., Cambridge).

The use of the initial Sr^{87}/Sr^{86} ratios of mafic rocks intruded into the crust at different times in the geologic past to reconstruct the evolution of mantle Sr throughout most of geologic time was considered. Preliminary results are included. (D.C.W.)

3998 (NYO-10517(p.127-8)) VOLCANIC ROCKS OF UNUSUAL COMPOSITION IN WESTERN ITALY. (Massachusetts Inst. of Tech., Cambridge).

Samples from eight volcanic vents from south of Naples to north of Rome were analyzed for Rb/Sr by x-ray spectrometry and for Sr isotope content. Absence of a significant variation in the Sr^{87} content that correlates with the alkali content of the rocks provides strong evidence against the concept of local assimilations as a cause of the observed variation in magma types. The Sr^{87}/Sr^{86} ratio, however, was not as low as oceanic basalts and seems to be specific for each vent. (D.C.W.)

3999 (NYO-10517(p.129-31)) APPLICATION OF LEAST SQUARES ANALYSIS TO Rb–Sr WHOLE-ROCK ISOCHRONS. H. W. Fairbairn (Massachusetts Inst. of Tech., Cambridge).

The method of least squares analysis gives a best fit line for an array of analyses with departures from perfect colinearity apparently due only to experimental errors. The method is demonstrated with data from a small area near Vernon, B. C., where there is a strong suggestion of correlation, but imperfect colinearity. (auth)

4000 (NYO-10517(p.133-4)) PROGRESS REPORT ON INITIAL $Sr^{87}-Sr^{86}$ IN IGNEOUS ROCKS. H. W. Fairbairn, P. M. Hurley, and W. H. Pinson (Massachusetts Inst. of Tech., Cambridge).

Data showing the variation of the initial Sr^{87}/Sr^{86} ratio in igneous rocks with the environment and origin of the sample are summarized. Factors contributing to the variation are discussed. (D.C.W.)

4001 (NYO-10517(p.143-5)) PRELIMINARY AGE STUDY AND INITIAL $Sr^{87}-Sr^{86}$ OF NOVA SCOTIA GRANITIC ROCKS BY THE WHOLE ROCK METHOD. H. W. Fairbairn, P. M. Hurley, and W. H. Pinson (Massachusetts Inst. of Tech., Cambridge).

An age study of twelve Nova Scotia granites by the Rb–Sr whole rock method shows a number of possible isochrons of which t at 373, 318, and 268×10^6 yr are preferred. The ages agree in a general way with the time scale for Acadian and Appalachian orogenies. The isochron envelope converges at zero Rb^{87}/Sr^{86} to a Sr^{87}/Sr^{86} zone between 0.705 and 0.711. As this range of values is consistently higher than that of oceanic and non-orogenic continental basalt, contamination by crustal material is postulated. Mica ages from the whole rocks of the 373×10^6 yr group are in general accord with the whole rock age. The majority of mica ages from rocks of the other two isochrons are anomalously 10 to 25% higher. (auth)

4002 (PNROO-DEV-124) ENVIRONMENTAL RADIOACTIVITY AT THE BETTIS ATOMIC POWER LABORATORY FOR THE SECOND SIX MONTHS OF 1962 AND FOR CALENDAR YEAR 1962. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 11, 1962. Contract AT-11-1-GEN-14. 20p.

Measurements of radioactivity in the liquid effluent and fallout, as well as measurement of background radiation intensities at the boundaries of the Atomic Power Lab. during the second six months of 1962, showed no significant contribution by the Laboratory operations to environmental radioactivity levels. Data are tabulated on radioactivity in samples of liquid waste effluent, soil, stream silt, air, and fallout. (C.H.)

4003 RUN-OFF OF CAESIUM-137 AND STRONTIUM-90 FROM RIVERS. Noboru Yamagata (Inst. of Public Health, Tokyo), Shinji Matsuda, and Kiyoshi Kodaira. Nature, 200: 668-9(Nov. 16, 1963).

Measurements were made on the concentrations of Cs^{137} and Sr^{90} in the River Tonegawa and at Kiriu City in Japan. The concentrations in rain water were calculated by dividing the monthly deposits by the monthly rainfall. An attempt was made to evaluate the run-off of a radionuclide in terms of the cumulative deposition and the deposition rate on the basis of an expression of the general form: $C = C_d + p_r C_r$ where C is the concentration of a radionuclide in the river water ($\mu\mu C/l$), C_r is the concentration of the radionuclide in the rain water ($\mu\mu C/l$) corrected for the evaporation (30% is assumed), p_r is a proportionality factor, and C_d is the concentration of the radionuclide in the river water that was derived from the cumulative deposition. The run-off by river of the ground deposits of Cs^{137} and Sr^{90} was estimated as 17.5 and 32 c, respectively, per annum on the basis of the mean concentrations (C_d) and the total discharge of 5×10^{14} l of river water in Japan. (P.C.H.)

4004 RADIOCARBON DATING: TECHNIQUES. S. Kusumgar, D. Lal, and V. K. Sharma (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 58: 125-37(Sept. 1963).

The radiocarbon method and the specific techniques that were used to date samples from Indian archaeological sites dating back to Harappa Culture are described. As a result of extensive radiocarbon determinations, a general confidence exists that, except in certain cases, the degree of contamination is usually small, being less than 2% in most cases. (P.C.H.)

4005 RADIOCARBON DATING: RESULTS. S. Kusumgar, D. Lal, and R. P. Sarna (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 58: 141-52(Sept. 1963).

A series of radiocarbon dates of archeological and geological samples are presented. The dates are based on 95% activity of the standard oxalic acid being the value for the pre-1900 age corrected wood. Two dates are given for each sample, depending on the value of $\tau_{\frac{1}{2}}$, the half life of radiocarbon, used. Certain definite conclusions regarding protohistoric chronology of India from the C^{14} dates are discussed. (P.C.H.)

4006 RADIOACTIVITY LEVELS IN LAKE MICHIGAN: A PRELIMINARY REPORT. Clifford Risley, Jr. (Dept. of Health, Education, and Welfare, Chicago). 18p. (CONF-117-5)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The contribution from fallout is probably the most significant source of radioactive pollution in Lake Michigan. In addition to fallout which occurs directly on the lake surface, fallout collected by surface runoff is contributed to the lake by the tributaries. These tributaries also carry

additional amounts of radioactivity from the permitted discharge of licensed radioisotope users. Although it was not operating at the time the samples were collected for this report, the recently completed Big Rock Point nuclear power reactor also discharges wastes to the lake. This is the only reactor on the lake or its watershed at present. Under normal operating conditions the radioactivity from this source is expected to be within acceptable limits. Water sample radioactivity analyses reveal only a few moderately high results. The few alpha results found which were greater than 3 $\mu\mu$C/l were all located in the southern half of Lake Michigan and all except one were more than ten miles from shore. The few moderately high beta results found (20 to 112 $\mu\mu$C/l) were evenly distributed between deepwater and inshore samples and randomly distributed throughout the entire lake. Studies of radioactivity in plankton samples also demonstrate the same random distribution of high results throughout the entire lake for both alpha and beta results. The highest radiation levels in plankton samples were obtained in the summer, simultaneously with the lowest result found in water samples. The ability of plankton to concentrate radioactivity may have been responsible for this observation. Further studies being made this year will provide additional information on the gross radioactivity in Lake Michigan. (auth)

Techniques and Equipment

Refer also to abstract 4112.

4007 (DPSPU-63-30-29) D_2O-Na^{24} METHOD FOR TRACING SOIL MOISTURE MOVEMENT IN THE FIELD. C. C. Haskell and R. H. Hawkins (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Oct. 1963. Contract AT(07-2)-1. 18p. (CONF-338-1)

From Soil Science Society of America, Denver, Nov. 1963.

A field method for observing movement of moisture through soil is described which is based on the detection of photoneutrons produced by the interactions of high-energy gamma rays with D in D_2O. The moisture probe consists of a Na^{24} gamma source and a slow-neutron detector; it is lowered into an access tube in the soil to determine the level and distribution of the D_2O previously injected in the soil as a moisture tracer. (D.L.C.)

4008 NEW POROUS STRATA MODELS FOR NEUTRON LOGGING. N. K. Kukharenko, Ya. N. Basin, Yu. P. Bal'vas, and Yu. V. Tyukaev. At. Energ. (USSR), 15: 338-9(Oct. 1963). (In Russian)

Successful use of neutron logging requires preparation of models for the porous layers. In order to overcome shortcomings of previously proposed models, a system was developed, characterized by the inclusion of artificial pores. The pores are simulated by horizontal cavities between layers and vertical openings in layers made of dense rock. The thickness of the layers and the distance between vertical openings were less than the mean free path of the fast neutrons. The pore volume was filled with the desired liquid. In the Monte-Carlo calculations used, the differences between pore size and distribution of the model and of the natural rock were taken into consideration. Tests were carried out with a model of a sandy layer with 40% porosity and a moisture content of 4%, which had moderating properties similar to a limestone with 1% moisture content. The additional H content was mocked up by horizontal celluloid layers and vertical vinyl plastic tubes filled with paraffin. The obtained neutron logging data showed that the H distribution in the model was equivalent to a level higher than the actual value by 7 to 11%. This supplementary fictitious water impregnation value can be easily estimated. The method was found useful for solving otherwise complicated geonuclear problems. (TTT)

4009 DISTRIBUTION OF THERMAL NEUTRONS IN SLOWING DOWN MEDIA AND IN APPLICATION TO PULSE NEUTRONOMETRY IN GEOPHYSICS. V. F. Zakharchenko (Inst. of Geophysics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 10, 1522-31(Oct. 1963). (In Russian)

Studies were made of thermal neutron distributions from a pulsed source. The influence of a slowing down medium on space-time thermal neutron distribution is discussed, and integral relations are offered for field attenuation. The sensitivity of the method to the chemical content of Li, B, Mn, Co, Cd, and Hg was evaluated. (tr-auth)

4010 INVESTIGATION OF THE MOVEMENT OF MOBILE BED MATERIAL IN THE ESTUARY AND ON THE COAST BY MEANS OF RADIOACTIVE MATERIAL. Syokichi Sakagishi (Japan Atomic Energy Research Inst., Tokyo). J. Oceanog. Soc. Japan, 19: 27-36(Apr. 1963).

Cobalt-60 was used as a tracer in an attempt to establish the origin of sands on the floor of Hiigata Harbor. In the first survey, a total activity of 140 mC was released in August at five points and the movement of labeled sands was followed by a GM counter until the end of October of the same year. The surveys showed that the sands moved relatively slowly in the summer. Labeled sand was found up to 100 m from the injection point within three months in the most dispersed area. In the second survey, a total activity of 500 mC was released in November in a similar manner, but at three points, instead of five. The subsequent movement of sand was measured in April of the following year in order to study the movement by storms during the winter. As a result, it was found that the activity due to nuclear detonations in the autumn of the previous year prevented accurate measurement. Because of the activity, nuclide analysis of sand samples taken from the bottom was performed using a pulse height analyzer. By this analysis it was confirmed that the main constituent (emitting gamma rays) was $Zr^{95}-Nb^{95}$, followed by Ru^{103} and $Ce^{142}-Pr^{142}$. The movement of littoral sands under sea water was investigated using Sc^{46}-glass as tracer at the west coast of Niigata for two months from April to May, 1962. This survey was carried out to determine the main direction of transport of the sand material in the sea area within 500 m of the coast line. By this survey, the trajectories of radioactive sands could be exactly determined. Then, the relation between the trajectory and oceanographical data (wave, current, etc.) was studied. The results suggested that the sands in this area were, as a whole, transported westward along the coast line through the year. (auth)

4011 METHOD AND APPARATUS FOR EARTH PENETRATION. William M. Adams (to U. S. Atomic Energy Commission). U. S. Patent 3,115,194. Dec. 24, 1963.

A nuclear reactor apparatus for penetrating into the earth's crust is described. The apparatus comprises a cylindrical nuclear core operating at a temperature that is higher than the melting temperature of rock. A high-density ballast member is coupled to the nuclear core such that the overall density of the core-ballast assembly is greater than the density of molten rock. The nuclear core is thermally insulated so that its heat output is constrained to flow axially, with radial heat flow being minimized. In operation, the apparatus is placed in contact with the earth's crust at

the point desired to be penetrated. The heat output of the reactor melts the underlying rock, and the apparatus sinks through the resulting magma. The fuel loading of the reactor core determines the ultimate depth of crust penetration. (AEC)

Thorium and Uranium Minerals

4012 (CEA-tr-R-1707) LES OCCURENCES URANIFÈRES PAR ÉVAPORATION DANS LES RÉGIONS ARIDES. (Uraniferous Occurrences Through Evaporation in Arid Regions). A. A. Kovalev. Translated into French from Vestn. Akad. Nauk. Kaz. SSR, 18: No. 3, 23-34(Mar. 1962). 28p.

In arid regions, in zones of eruptive and sedimentometamorphic rocks, there is a high U occurrence. The great majority of these occurrences, constituted by schrockingerite and uranophane and some secondary U minerals, has a superficial character. Because of the coincidence with zones of fracture and hydrothermal alteration of the encasing rocks, the secondary accumulation can be considered as oxide outcrops of hydrothermal deposits of U. The essential geological peculiarities of the secondary U accumulations near the surface allow a differentiation of the oxide outcrops. The essential processes of formation of the secondary accumulations of U is the evaporation of uraniferous waters. The source of U in the beds formed by evaporation is essentially from rocks possessing a high U concentration. (J.S.R.)

4013 BENEFICIATION OF PEGMATITIC URANIUM ORES FROM JAPAN. Kenji Tomita and Tadaya Hoshino. Nippon Kogyo Kaishi, 79: 604-11(Aug. 1963). (In Japanese)

Ore sample A, which is rich in feldspars and micas and poor in quartz, and ore samples B and C, which are rich in quartz and feldspars and poor in micas, were selected for investigation as the typical pegmatitic uranium ores in Japan. In ore sample A many varieties of radioactive minerals such as fergusonite, columbite, samarskite, and uraninite are present. In ore sample B euxenite is predominant accompanied by monazite, while in ore sample C, uraninite is the only radioactive mineral. The beneficiation characteristics of these ores were investigated using a shaking table, a dipole magnetic separator, an electrostatic separator, and flotation with fatty acid and petroleum sulfonates. The results indicated that gravity concentration and flotation were the most effective processes, whereas magnetic concentration and electrostatic separation were effective only for supplementary separations. It was recognized, therefore, that the effectiveness of beneficiation of the pegmatites depends upon a combination of processes. A combination of gravity and magnetic concentration was suitable for ore A, gravity and flotation was best for sample B, and flotation was the only effective method for sample C. (auth)

HEALTH AND SAFETY

Refer also to abstracts 3566 and 4079.

4014 (AECL-1863) RADIOACTIVITY IN PRECIPITATION COLLECTED AT CRNL AND NPD. CRNL ENVIRONMENTAL SURVEY AND NPD PRE-OPERATIONAL SURVEY, JUNE 1960 TO DECEMBER 1962. J. E. Guthrie and W. E. Grummitt (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). July 1963. 32p.

From June 1960 to December 1962, monthly samples of precipitation were collected near CRNL and NPD and analyzed for various radionuclides. Strontium-90 and Cs^{137} in rain and snow showed peak concentrations in the spring of 1961 and 1962 attributable to the removal of nuclear weapons debris from the stratosphere. Statistical analysis of the measurements showed that there was a greater degree of variability among those from CRNL than among those from NPD. One collector site at CRNL, in particular, had a significantly greater degree of variation. Iodine-131 from CRNL was detected in October and November 1960. It is suggested that some Sr^{90} and Cs^{137} may have been released at the same time. However, the amount deposited did not make a significant addition to the cumulative total from fallout. (auth)

4015 (AED-C-05-04) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. STRAHLENKONSERVIERUNG UND KONTAMINATION VON LEBENSMITTELN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Radiation Preservation and Contamination of Food. Bibliographic Compilation). U. Schuetzsack, comp. (Germany. Bundesforschungsanstalt für Lebensmittel-Frischhaltung, Karlsruhe). Sept. 1963. 84p.

Two hundred and eighty-nine references on radiation preservation and contamination of food are presented. Report number, author, and subject indexes are included. (M.C.G.)

4016 (AED-C-13-03) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. DEKONTAMINATION. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Decontamination. Bibliographic Compilation). H. Philipp, comp. (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany). Aug. 1963. 80p.

A bibliography of articles, reports, and patents published before Dec. 31, 1962, on decontamination of buildings, laboratories, large surfaces, reactors, instruments, clothing, materials, persons, animals, liquids, and gases and on decontamination instruments and installations is presented. There is a report, patent, and author index. 90 titles with abstracts are included. (J.S.R.)

4017 (HW-SA-3176) USE OF METEOROLOGICAL MEASUREMENTS FOR PREDICTING DISPERSION FROM RELEASES NEAR GROUND LEVEL. James J. Fuquay and Charles L. Simpson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 24p. (CONF-337-1)

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

Atmospheric dispersion studies conducted at Hanford are briefly described as to experimental technique and scope. The theoretical basis for summarization of exposure data in terms of travel time are reviewed. Results are presented for the decrease of maximum exposure and horizontal plume growth as a function of travel time. Prediction parameters are developed from meteorological measurements of vertical temperature profiles in the boundary layers and the wind speed and direction near release height. The local Richardson Number and the product of the wind speed and standard deviation of wind direction are shown to correlate well with the experimental data. A method is described for predicting exposures from protracted releases in which multimodal, flattened, or skewed distributions are often observed. (auth)

4018 (HW-SA-3210) RADIOACTIVE PARTICLE RETENTION IN AEROSOL TRANSPORT SYSTEMS. L. C. Schwendiman, G. A. Sehmel, and A. K. Postma (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1963. Contract AT(45-1)-1350. 36p. (CONF-337-1)

From International Conference on Padioactive Pollution of Gaseous Media, Saclay, France).

The practical importance of particle deposition in aerosol transport systems under several situations of air flow, conduit diameter, particle size, and other variables is discussed. Diffusion of very small particles, gravitational settling in horizontal pipes with laminar flow, thermal, and electrical precipitation are considered with tables to show what might be expected in some practical situations. Turbulent deposition is an important mechanism for impacting particles on the wall of a conduit. The experimental findings are presented and discussed with emphasis on the practical significance of turbulent deposition. The deposition constant is shown to be controlled by approximately the fifth power of the duct velocity and the fourth power of particle diameter. Other variables are density and viscosity of the gas, and the density of the particle. Significant deposition of 1–10 micron particles in small diameter conduits was observed. Recently obtained data on turbulent deposition in tube bends are presented. Serious wall losses in 90°-bends can be anticipated in practical situations. (P.C.H.)

4019 (LAMS-2959) HEALTH PHYSICS PLANNING FOR A HIGH-PRESSURE TRITIUM GAS EXPERIMENT AT A UNIVERSITY. Morris J. Engelke (Los Alamos Scientific Lab., N. Mex.). July 1963. Contract W-7405-eng-36. 32p.

A discussion is presented of the problems encountered in the use of a multi-curie high-pressure tritium gas target at a large university. The necessary administrative arrangements, state licensing, transportation, and health physics problems are discussed. (auth)

4020 (NAA-SR-Memo-2068) COMPARISON OF MULTI-SPRAY VS. DELUGE SAFETY SHOWER. John D. Gracie (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 22, 1957. Contract [AT(11-1)-Gen-8]. 10p.

Multi-spray and deluge type showers were used to remove solid sodium from the clothing of a plaster mannequin. Temperature measurements and visual inspection of the garments and the painted "skin" surface pointed to the multi-spray shower as the more effective emergency unit and confirmed the advisability of strict adherence to certain current sodium safety precautions. (auth)

4021 (NAA-SR-Memo-9168) STORAGE OF HALLAM CORE II FUEL ROD CLUSTERS. Norman Ketzlach (Atomics International. Div. of North American Avia-

tion, Inc., Canoga Park, Calif). Oct. 29, 1963. Contract [AT(11-1)-Gen-8]. 9p

A review was made of the nuclear safety of the Hallam maintenance cell for handling the 5.0% U^{235}-enriched UC clusters as well as the 3.6% U^{235}-enriched U–10 Mo fuel element clusters. It is not possible to make a single row of either fuel element clusters critical independent of the degree of water flooding or the length of the row. (auth)

4022 (NP-13312) SOURCES OF ERROR IN MONITORING AND SURVEY PROGRAMMES DUE TO SAMPLING AND THEIR ESTIMATION. Hans H. Donth (Germany. Bundesministerium für Wissenschaftliche Forschung, Bad Godesberg). [1962]. 61p.

Sampling techniques and mathematical statistics in programs for the monitoring and surveying of environmental radioactivity were reviewed. Topics discussed are: the meaning of statistical terms in surveys on environmental radioactivity, estimation of the sampling error, the total error, sample selection, and standard deviation of individual values and confidence regions for mean values. (A.M.G.)

4023 (NP-13388) RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM, 1962 RESULTS. (Gt. Brit. Ministry of Housing and Local Government, London; Gt. Brit. Secretary of State for Scotland. Scottish Development Dept., Edinburgh; and Northern Ireland. Ministry of Health and Local Government, Belfast). 1963. 24p

During 1962 the concentration of strontium-90 and cesium-137 has been measured regularly in twenty-four public drinking waters. Virtually none was found in deep well waters at Brighton and Wolverhampton. Very low concentrations were found in the Folkestone supply from shallow wells at Denge Beach. In the only water derived from a chalk stream, Southampton, the level of strontium-90 was low (0.065 picocurie/litre). In the river-derived waters except Southampton and London, the average level of strontium-90 was 0.36 picocurie/litre; London's water was somewhat higher than this (0.43 picocurie/litre). Excluding London's River Thames water (the average level of which was 0.55 picocurie/litre), the average concentration of cesium-137 in river-derived waters was 0.037 picocurie/litre. The average annual level of strontium-90 in individual impounded waters ranged from 0.37 picocurie/litre to 1.03 picocurie/litre; the average annual level for all these waters was 0.81 picocurie/litre. The average annual concentration of cesium-137 in impounded waters was 0.23 picocurie/litre; annual averages for the individual supplies ranged from 0.037 picocurie/litre to 1.10 picocurie/litre. The average daily ingestion of strontium-90 and cesium-137 in drinking water in 1962 is estimated at 0.41 picocurie per person and 0.16 picocurie per person respectively. These amounts are small compared with the average daily intake in the diet. The measurement of the principal fission products in drinking water has confirmed that strontium-90 is the most important one to determine. Water in the upper reaches of streams has been shown in general to contain only a small fraction of the iodine-131 present in rain. (auth)

4024 (NP-13391) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 1, No. 11. (Canada. Dept. of National Health and Welfare, Ottawa). Nov. 1963. 47p.

In English and French.

Current data from the various programs being carried out by the Radiation Protection Division of National Health and Welfare are reviewed. The most recent analytical results on the fallout monitoring program are included. In addition to the fallout analyses, data are presented from the programs on reactor environment monitoring, personnel dosimetry (film monitoring), isotope safety assessments, and field investigations of radiation safety. (auth)

4025 (ORNL-3479) SAFETY ANALYSIS OF THE OPERATION OF THE HIGH-RADIATION-LEVEL EXAMINATION LABORATORY. A. R. Olsen, J. P. Nichols, and Sigfred Peterson (Oak Ridge National Lab., Tenn.). Dec. 5, 1963. Contract W-7405-eng-26. 89p.

The High-Radiation-Level Examination Laboratory (HRLEL) is described and an evaluation of the consequences of the most serious accidents that could possibly occur in the facility is given. The HRLEL is built and equipped to permit remote disassembly and complete examination of highly irradiated materials, including reactor fuel elements, other reactor components, and irradiation experiments within the completely contained complex of shielded cells. The structural and mechanical features of the building are reviewed in the light of proposed operations and credible accidents. The resulting data outline the effects of such accidents on personnel and the environs from the viewpoints of possible radiation exposure and contamination. The maximum credible effects are presented along with the contingent controls that reduce the probability of such accidents ever happening to near zero. (N.W.R.)

4026 (TID-19754) PROTECTIVE CLOTHING STANDARDS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 57p. (HWS-10007)

Hanford Atomic Production Operation specification guides for protective clothing are presented. Details of this manual are given in TID-4100(Suppl.). (N.W.R.)

4027 (USNRDL-TR-672) DESIGN CRITERIA FOR ROOF WASHDOWN SYSTEM. PHASE 1. FALLOUT REMOVAL STUDIES ON TYPICAL ROOFING SURFACES FOR TWO SIZE RANGES OF PARTICLES (177-350 μ AND 350-590 μ). R. H. Heiskell, W. S. Kehrer, N. J. Vella, and G. Brown (Naval Radiological Defense Lab., San Francisco). July 18, 1963. 75p.

Fallout simulant particles ranging in size from 177 to 350 and 350 to 590 microns were deposited on selected typical roof sections 48 ft long by 8 ft wide to determine the effect of water flow rate, slope, and surface type on washdown effectiveness. More than 90% of the simulant can be removed on composition shingles, aluminum shingles, and roll roofing at slopes of 1:12 or steeper with 2 to 3 gallons of water per min per ft of roof width (gpm/ft). It was found that washdown is ineffective on tar and gravel roofing without prior removal of the loose gravel. Washdown on a fiberglass epoxy laminated roof will remove better than 99% of the simulant particles with a water flow rate as low as 1 gal/min/ft. (auth)

4028 TRAPPING OF SHORT-LIVED RADON DECAY PRODUCTS WITH FP-TYPE FIBER FILTERS. B. I. Ogorodnikov, V. N. Kirichenko, P. I. Basmanov, and I. V. Petryanov. At. Energ. (USSR), 15: 230-7(Sept. 1963). (In Russian)

Filtering materials fabricated from polymeric fibers are widely used for the removal of finely dispersed radioactive aerosols; their filtering efficiency was therefore examined, comparing the various available materials on the basis of their ability to retain the short-lived daughters of Rn^{222}. This nuclide is an intermediate product of the U–Ra decay chain and diffuses continuously into the atmosphere from uraniferous deposits. In view of the importance of the filters for the protection of uranium miners and ore treat-

ment plant operators, the tests were carried out both under laboratory conditions and at an experimental mining site. It was found that the filtering efficiency depends primarily on the basic properties of the material, such as aerodynamic resistance, fiber diameter, and the presence of electrostatic charges and also on the filtration rate and the degree of dispersion of the aerosol. Linear flow velocities from 1 to 200 m/sec were used for the tests. At high linear velocities, filters made of 0.5 and 1.34-micron thick fibers were found to be the most effective; at a standard resistance of 1 mm of water gauge at least 99% of the Rn daughters were retained by the filters. Use of these materials for large-scale industrial filters, for personnel protection and for analytical purposes is also reviewed. (TTT)

4029 "HOT" AEROSOL PARTICLES IN THE ATMOSPHERE. S. G. Malakhov and K. P. Makhon'ko. At. Energ. (USSR), 15: 238-45(Sept. 1963). (In Russian)

Large amounts of aerosols are formed in the atmosphere as a result of the nuclear tests; a portion of these aerosols consisting of large, highly active particles are deposited in the immediate vicinity of the explosion but the rest are carried by aerial currents all over the earth. This global fallout also contains highly active individual particles, reaching levels of 10^{-8} curie per single particle. The behavior of these "hot" particles is reviewed on the basis of literature data. These particles, having activities ranging from 10^{-10} to 10^{-8} curie, represent levels normally found distributed in 10^2 to 10^4 m^3 of air and therefore they represent a serious health hazard. The published studies have concentrated on the following aspects of the problem: physico-chemical behavior, geophysical distribution, and health physics problems. The hot particles present a special problem for the photographic industry; they also interfere with fallout measurements. By means of radiometric measurements it was found that the hot particles contain Ce^{141}, Ce^{144}, $Zr^{95} + Nb^{95}$, Pr^{142}, I^{131}, Ru^{103}, Nd^{147}, Ba^{140}, and La^{140}; other authors also identified U^{237}, Np^{239}, Te^{132}, and Mo^{99}. By means of β spectrometry, $Sr^{90} + Y^{90}$ were also found. Health physics considerations make it imperative to continue research on the danger presented by the presence of hot particles in the atmosphere and to review critically the maximum permissible concentrations of radioactive materials in the air. 57 references. (TTT)

4030 THE PRESENCE OF HOT, α-EMITTING AEROSOL PARTICLES IN THE ATMOSPHERE. B. I. Styro, Ch. A. Garbalyauskas, V. P. Matulevichus, V. Yu. Potsyus, and K. K. Shopauskas. At. Energ. (USSR), 15: 262-4(Sept. 1963). (In Russian)

As a result of atomic bomb testing, particles with activities up to 10^{-9} C are formed in the atmosphere; their concentration is 1 particle per 10 to 1000 m^3 of air. In view of studies previously carried out on β and γ-active particles, the α-emitting particles were investigated. It was found that the hot particles as a rule, do not leave proton or α tracks on x-ray film; however, α tracks were observed in 3 instances. The samples in which these particles were found were collected from cumulus clouds at a height of 700 m above the ground, by precipitation using an industrial cyclone from air near the ground, and by filtering air at 500 to 1000 m. The activity of the 3 particles was determined from 24, 39, and 82 tracks, respectively, as 0.4×10^{-14}, 1.1×10^{-14}, and 7.1×10^{-14} C. The activity is probably due to the presence of the following elements: Np^{237}, Ac^{225}, Fr^{221}, Po^{213} (neptunium family), and also Pu^{239}, U^{235}, Pa^{231}, and Bi^{211}. The ionizing effect of these particles is probably similar to that of the ordinary hot particles. (TTT)

4031 RADIOACTIVE FALLOUT IN CRIMEA DURING 1960-61. L. I. Belyaev, L. I. Gedeonov, Z. G. Gritchenko, A. M. Maksimova, V. P. Shvedov, and G. V. Yakovleva. At. Energ. (USSR), 15: 264-5(Sept. 1963). (In Russian)

Daily radioactive fallout measurements were carried out during 1961 and 1962 in the vicinity of Simeiz. The samples were collected on a 1 m^2 surface metallic recipient. The fission product buildup was derived from absolute β-activity measurements. It was found that the fission-product activity remained constant at about 0.1 C/km^2, except during February 1960 when it rose suddenly to 0.4 C/km^2. The constancy of the values is due to the temporary suspension of the bomb tests during the period; the increase was caused by the explosion of the French atomic bomb in the Sahara on February 13, 1960. Some of the samples collected were analyzed by scintillation γ counters provided with NaI(Tl) and CsI(Tl) crystals. From the values of the Ru^{103} and $(Zr + Nb)^{95}$ photopeaks of the specimens collected after the Sahara explosion it was concluded that Pu^{239} was used in the French bomb. The dose calculated at the Simeiz region attributable to the products of this explosion amounted to 0.82 mr for 1960. The Cs^{137} and Sr^{90} concentrations were found to change exponentially with a decay half life of 20 and 19 months, respectively. (TTT)

4032 THE SECONDARY DUST COMPONENT OF THE RADIOACTIVE CONTAMINATION OF THE GROUND LAYER OF THE ATMOSPHERE. B. I. Styro, Ch. A. Garbalyauskas, V. I. Lyuanas, V. P. Matulyavichus, T. N. Nedvetskaite, and I. S. Tomkus. At. Energ. (USSR), 15: 339-41(Oct. 1963). (In Russian)

In order to separate material lifted by the wind from the ground from finely dispersed radioactive dust in the atmosphere, samples were taken during July and August, 1961 at various geographic points, which included a sandbar separated from the mainland by 12-km wide bay, a piling placed in the water and points at the shore. The radioactive fallout was collected on the surface of distilled water placed in containers at a height of 0.8 m from the ground or about 5 m above the sea level. The water was changed every 10 days and the residue from evaporation at 500°C was calcined. The activity of the specimens was measured, taking the self-absorption into account, and the Sr^{90} concentration was determined radiochemically. Large amounts of solids were obtained at the sampling station surrounded by sandy areas. The minimum of activity of the fallout was obtained at the piling surrounded by sea water; its distance seems to represent the limit of the coprecipitation of continental dust with the radioactive fallout. The Sr^{90} determinations indicated that about 10% of the total activity is due to the "dry fallout." Assuming that the over-water deposit contained only negligible amounts of this secondary dust component, the activity carried by the fallout is estimated at 0.27 microcurie Sr^{90}/km^2 mm. It was concluded that whenever the secondary component exceeds 35%, it must be taken into account when calculating the cumulative activity due to fallout. (TTT)

4033 MEASUREMENT OF RADIATION. Atomics, 16: No. 6, 22-7(Nov.-Dec. 1963).

Radiation measurement is dependent for detection and evaluation upon physical, chemical, and electrical effects on materials. In terms of radiation protection, radiation measurements have a threefold purpose: determination of external exposure of an individual, evaluation of potential radioactivity intake by man and animals, and determination of radioactivity levels existing within man. Basic principles of the following radiation detection and measurement devices are discussed: ionization chambers, scintillation detectors, solid state chambers, dosimeters

and film badges, and pulse height and multichannel analyzers. Radioactivity sampling techniques are described. (H.M.G.)

4034 HEALTH PHYSICS AND CONTROL OF RADIATION EXPOSURE. Atomics, 16: No. 6, 28-30(Nov.-Dec. 1963).

Health physics is concerned with an understanding of the mechanisms of radiation damage, with the development and implementation of methods and proceedings necessary to evaluate radiation hazards, and with providing protection to man and his environment from unwarranted radiation exposure. Duties and responsibilities of the health physicist are described. Since 1928 a variety of national and state agencies concerned with problems of radiation protection have endeavored to establish and enforce standards of radiation exposure. It is pointed out that the task of these agencies is complicated by the fact that numerical application in radiation protection is largely a matter of judgment and cannot be proven conclusively. (H.M.G.)

4035 DEVELOPMENT AND EXECUTION OF RADIATION PROTECTION PROCEDURES IN UNDERGROUND MINING. R. Reiter. Beispiele Angew. Forsch., 119-30 (1963). (In German)

Radiation hazards from uranium, thorium, and their daughter products during mining are discussed. Protection methods are described. (M.C.G.)

4036 RADIOACTIVE FALLOUT IN THE AIR AND RAINWATER. RESULTS FROM 1959 TO 1962. J.-Cl. Philippot and G. Hemon. Bull. Inform. Sci. Tech. (Paris), No. 75, 135-56(Aug.-Sept. 1963). (In French)

Data are given on the distributions of Cs^{137}, $Sr^{90}-Y^{90}$, Sr^{89}, $Ru^{106}-Rh^{106}$, and $Ce^{144}-Pr^{144}$ in the air and rainwater at four widely separated stations in France. The samples are taken at ground level. Temporal variations in these activities, as well as the total activity, are measured at each of these stations. (T.F.H.)

4037 ELECTRON SPECTROSCOPY IN HEALTH PHYSICS RESEARCH. R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Health Phys., 9: 973-86(Oct. 1963).

Electron spectrometers may be classified by the energy-differentiating mechanism employed, as magnetic, electrostatic, scintillation, proportional counter, or semiconductor. Each type offers particular combinations of transmission, resolution, and energy acceptance from 0.01 to 100 per cent, 0.001 to 25 per cent, and 1 ev to many Mev, respectively. Solid sources are usually used and these sources may range in diameter from a fraction of a mm to 10 cm. Energy calibration is usually accomplished using internal conversion electrons or an electron gun or accelerator. Measurement of transmission is made by noting deviation, if any, from a Fermi plot of an experimental β spectrum from an allowed transition. Uses in health physics include measurements of: shapes of β spectra which determine shapes of β-absorption curves, branching ratios, and average energies per disintegration, all of which are used in internal dose calculations; cross sections for electron-electron interactions in solids and gases; slowing down spectra of β rays, Compton- and photoelectrons in solids; β-spectra from unknown emitters for identification. As monochromators, they select a narrow energy band from a β-ray continuum which may be used to measure efficiency of scintillators and energy dependence of β-ray dosimeters. (auth)

4038 SOME CONSIDERATIONS ON PROTECTION AGAINST IONIZING RADIATIONS IN SMALL COUNTRIES BESIDE THE IMPORTANT NUCLEAR ENERGY CENTERS. E. E. Godfroi, J. Govaerts, and G. Guében (Universite, Liège). Health Phys., 9: 1005-8(Oct. 1963).

In Belgium, overall responsibility for the radiation protection of nuclear workers and the population as a whole is assigned to the Ministry of Labor and the Ministry of Public Health. These ministries have formulated and issued protection regulations generally based on the recommendations published by Euratom. To obtain license to use radioactive materials in Belgium, the future user must prove to the ministerial authorities that his organization is qualified to handle such materials safely. Special medical controls must be provided including periodic physical examination of all nuclear workers for the detection of radiation injury or disease. Although the requirements for license do not absolutely neglect the physical aspects of the licensee's protection program, specific methods and practices to achieve effective protection are not emphasized or well defined in the existing regulations. That the total research and development effort in nuclear sciences in small countries may be rather limited in comparison to nations having the larger nuclear centers is recognized. Consequently the number of graduate level health physicists available in small countries may be correspondingly limited. To fulfil this need and to enable small nations to provide effective protection for their nuclear workers, the following solution is proposed. Small countries should: establish special training programs for health physicists in regions where the industrial and medical use of nuclear energy is developing and expanding; limit the number of graduates of these health physics training programs in accordance with the real needs of the country; establish health physics teams to provide technical services and consultation to all users of radionuclides within each general industrial area; provide each team with well-suited instrumentation. Consideration is given to the importance of professional collaboration between individuals and groups concerned with radiation protection. Suggestions are made to promote wholesale collaboration between health physicists and health physics sections within each country and between these groups and the national and international organizations concerned with radiation protection. (auth)

4039 NUCLEAR FALLOUT AFTER MEGATON NUCLEAR TESTS IN 1961–1963. Vilem Santholzer (Karlova Univ., Hradec Kralove, Czechoslovakia). Jaderna Energie, 9: 310-14(Oct. 1963). (In Czech)

By measuring the activity of atmospheric fallout in 1961 to 1963 it was proved that the mean residence time of fission products in the stratosphere after megaton nuclear tests is longer than it was in 1959 and 60 after nuclear tests which were mostly of a smaller caliber. This results in prolongation of "decontamination half period" of the atmosphere from fission products. The question of periodical variations of nuclear fallout activity caused probably by movements of air masses in the low stratosphere was also studied. The solution of this question is still at initial stage. (auth)

4040 A γ RAY SPECTROMETRIC METHOD FOR THE MEASUREMENT ON FALL-OUT CONTAMINATED SAMPLES. Mikio Yamashita and Hironobu Watanabe (National Inst. Radiological Science, Japan). Nippon Genshiryoku Gakkaishi, 5: 823-7(Oct. 1963).

A statistical method for analyzing the spectra and an experimental method for estimating a relative photopeak efficiency vs. energy are described. In this method, only one standard of certain energy is needed, and subsequent absolute measurement for other nuclides can be attained with a knowledge of a relative photopeak efficiency. (auth)

4041 ANALYSIS OF RADIOACTIVE FALL-OUT IN AIR AT HIGH ALTITUDE BY THE METHOD OF γ RAY SPECTROSCOPY. Tatsuo Urai (Japan Defense Agency). Nippon Genshiryoku Gakkaishi, 5: 828-32(Oct. 1963).

The sample was collected in the Chubu district of Japan on Nov. 10, 1961. From the γ-ray spectrum it seems that this sample is composed of fallout which was probably caused by the test of a 50 Mt nuclear weapon of the U.S.S.R. (auth)

4042 WAR AND THE LIVING ENVIRONMENT. Robert H. Wurtz. Nucl. Inform., 5: No. 10, 1-20(Sept.-Oct. 1963).

Long term effects of nuclear war on the complex, interrelated world of living things are considered. Local and worldwide fallout effects, late somatic effects, and radiosensitivity of various organisms are discussed. (H.M.G.)

4043 HAZARD FROM NEVADA TESTS. A Reply to the Atomic Energy Commission. Nucl. Inform., 6: No. 1, 1-2(Nov. 1963).

On August 21, 1963, at the invitation of the Joint Committee on Atomic Energy, the Greater St. Louis Citizens' Committee for Nuclear Information (CNI) submitted testimony regarding the possible hazard of nuclear testing at the Nevada Test Site to children living in nearby regions. Subsequently, a detailed critque of the CNI testimony was submitted to the Joint Committee by Dr. Gordon Dunning in behalf of the AEC. Comments are made on Dr. Dunning's criticism by the CNI. (H.M.G.)

4044 STATEMENTS FROM "DISCUSSION OF IODINE 131 IN FALLOUT." Gordon M. Dunning. Nucl. Inform., 6 No. 1, 3-13(Nov. 1963).

An analysis is presented of the fourteen specific assertions made by AEC's Dr. Gordon Dunning to the Joint Committee on Atomic Energy relative to Committee for Nuclear Information testimony on hazards to children from nuclear testing at the Nevada Test Site. (H.M.G.)

4045 EXPERIMENTAL ESTIMATION OF EFFECTIVENESS OF FILTERS AGAINST RADIOACTIVE AEROSOLS. A. Stankovicova and F. Minarik. Pracovni Lekar., 15: 343-4(Oct. 1963). (In Czech)

The efficiency of five filter materials for the removal of radioactive aerosols was evaluated. The β activity of the filters was measured after air labeled with Po^{218} and Pb^{214} was passed through them. Membrane filters were the most efficient. (C.H.)

4046 ATMOSPHERIC PROBLEMS CREATED BY NUCLEAR-PROPELLED SUBMARINES. R. Guillerm and R. Badre (C.E.P.S.M., Toulon, France). Rev. Corps Sante Armees, 2: 485-514(Aug. 1961). (In French)

The problems discussed here arise from the greater fuel capacity and consequent greater range of the atomic submarine, in comparison to the traditional vessel, and from maintaining proper atmospheric conditions for men continuously submerged over long periods of time, e.g., several weeks. Protection against radiation is minor among problems encountered. Atmospheric factors on the vessel include metabolic gases: oxygen and carbon dioxide contained in nitrogen, an inert gas; pollution from gases and vapors of human, artificial, or accidental origin; ion factors; and temperature-humidity factors. An oxygen analyzer is essential to follow oxygen consumption and to provide a minimum necessary level of 30 l/man/hr. Experiments were done in an air-tight chamber to determine the exact rate (24 l/man/hr) of CO_2 production when the minimum necessary oxygen concentration and exercise were maintained; an infrared absorption analyzer was used to measure CO_2. The partial pressure of CO_2 registered by these analyzers correlated with the physiological effect of the gas. Traditional methods of minimizing CO_2 concentrations and producing oxygen prove somewhat cumbersome on a large scale. New methods in use are continuous production of oxygen by electrolysis and constant absorption of CO_2 by monoethanolamine. Possible long-term methods suggested include the use of chlorophyll to convert CO_2 to O_2. Methods used to control atmospheric pollution are: air conditioning, to remove vapors of human origin; electrostatic precipitations, to absorb cooking vapors and to dissipate smoke; removal of hydrocarbons by means of activated charcoal; control of hydrogen given off by storage batteries by Hopcalite; measurement of nitrous oxides and ozone to prevent their accumulation. Accidentally released products, such as refrigerant fluids, mercury vapor, and smoke from machinery or fire, must not be allowed to accumulate over long periods of time. Infrared analyzers used for CO_2 assay can also be used to measure hydrocarbons and Freon. Hydrogen content of the air is measured by a hygrometer B.G. composed of a Wheatstone bridge with platinum sensors. Positive or negative ions in the atmosphere, classified as light (ionized gases), medium, or heavy (charged aerosols), produce physiological effects in concentrations exceeding 100,000 ions/cm^3. Control of such ions requires determination of ionic charge density by an electrometric filter and use of an apparatus capable of producing or absorbing positive or negative ions. Further progress along these lines should make atmospheric conditions on nuclear-propelled vessels amenable to longer periods of submersion than now possible. (BBB)

4047 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME IV, NUMBER 11. (Public Health Service, Washington, D. C.). Nov. 1963. 36p. (RHD-Vol. IV, No. 11) $0.50(GPO).

Data are presented on levels of radioactivity from fallout in samples of airborne particulates, precipitation, surface waters, and milk collected throughout the U.S., Canada, and Mexico during 1963. Data are included on the Sr^{90} content of human vertebra collected from March 1962 to March 1963 at New York City, Chicago, and San Francisco; and on the Cs^{137} content of residents of West Germany as determined by whole-body counting at Landstuhl from March to July, 1963. Environmental levels of radioactivity in the vicinity of Atomics International, Canoga Park, Calif., during 1962 are reported. Data are summarized on four nuclear detonations at the Nevada Test Site announced during October, 1963. (C.H.)

4048 ANTENNA SURVIVABILITY UNDER NUCLEAR ATTACK. Malcolm A. Stephens (Martin Co., Orlando, Fla.). 18p. (CONF-326-2)

From 7th National Convention on Military Electronics, Washington, D. C., Sept. 1963.

The importance of antennas for every phase of communication and in the special case of nuclear attack is discussed. The means for achieving antenna survival are presented for dispersion, redundant, and physically hardened antennas. The effects of a nuclear explosion on antennas are discussed. (R.E.U.)

4049 AIR-COOLED SHIPPING CONTAINER FOR NUCLEAR FUEL ELEMENTS. Alfred N. Rogers (Baldwin-Lima-Hamilton Corp.). U. S. Patent 3,111,586. Nov. 19, 1963. Filed Aug. 25, 1961.

A container for spent fuel elements, which requires no moving parts or driving means for its cooling equipment,

is described. Water immersion is not necessary for a high safety factor, but instead, natural convective air flow is sufficient. (R.E.U.)

4050 CASK CONSTRUCTION FOR RADIOACTIVE MATERIAL. John W. Allen (to Stanray Corp.). U. S. Patent 3,113,215. Dec. 3, 1963. Filed Feb. 27, 1961.

Casks designed for transporting radioactive materials are described. The casks have inner and outer shells in spaced relation with shielding material between the shells. The shells are constructed of finned sections to provide high thermal conductivity. The outer shell has attached banks of fins to provide additional thermal conductivity. (M.C.G.)

INSTRUMENTATION

General

Refer also to abstract 4141.

4051 (EUR-475.i) CARATTERISTICHE LOGICHE E CIRCUITALI DELL'ANALIZZATORE DI TEMPI DI VOLO A 1024 CANALI COSTRUITO IN ISPRA. (Logical Design and Circuit Characteristics of the 1024 Channel Time of Flight Analyser Built in Ispra). I. De Lotto and A. Termanini (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 39p.

The design and circuit characteristics of the 1024 channel time-of-flight analyzer are presented. Data handling systems for multi-parameter recording are reviewed. Diagrams are given for the temporary store and programmer of the modes of operation. The design conditions of the most important circuits of the analog-to-digital converter, temporary store, and input channels are examined. The instrument is used with the fast chopper built in Ispra. (auth)

4052 (LF-12) THE STAGE CONSTANTS OF CASCADE IMPACTORS. Technical Progress Report. T. T. Mercer (Lovelace Foundation for Medical Education and Research, Albuquerque, N. M.). Oct. 1963. Contract AT (29-2)-1013. 20p.

The particle size distributions which would be found on each stage of a cascade impactor when used to sample an aerosol having a lognormal mass distribution were calculated. Three impactors, differing with respect to the collection characteristics of the various stages, were assumed. Samples were obtained from hypothetical aerosols having a wide range of distribution parameters. It is shown that for a particular aerosol the particle sizes appear to be lognormally distributed on all stages and that the mass median diameter for a given stage, calculated from the number distribution on that stage, is a good estimate of the true mass median diameter for that stage. The true mass median diameters and true effective cut-off diameters for each stage and for each aerosol were calculated also. The latter are shown to be superior for interpreting impactor data. (auth)

4053 (LNF-63/50) PROPOSTA PER UNA UNITA' DI SELEZIONE E REGISTRAZIONE AUTOMATICA DI IMPULSI. (Proposal for an Automatic Pulse Selection and Recording Unit). Note No. 207. M. Coli and A. Serra (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 12, 1963. 20p.

The criteria followed in the design of the automatic pulse selector and recorder are operational stability, flexibility, electrical standardization and unit construction, automation, and data recording. The principal electrical and mechanical characteristics are tabulated, and the design of the selector is given in detail. (J.S.R.)

4054 (MATT-212) DIFFERENCES BETWEEN NUDE AND ENCLOSED ION GAUGES ON AN OIL-FREE SYSTEM. Edward Apgar (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1963. Contract AT(30-1)-1238. 28p. (CONF-350-1)

From European Conference on Vacuum, Frankfurt, Germany, June 1963.

High-conductance nude and low-conductance glass-enclosed tubulation ion gages were compared on an oil-free, all-metal, bakeable, ultrahigh-vacuum system over the pressure range 10^{-10} to 10^{-5} torr. Large differences in pressure indication were observed with CO, the tubulation gage reading consistently less than the nude gage. Smaller differences in the same direction occurred with H_2 and N_2 and none with He. Heating the tubulation or maintaining the pressure above 10^{-7} torr reduced the differences. An explanation is offered in terms of adsorption in the tubulation and a low effective conductance. (auth)

4055 (NP-13372) THE PERFORMANCE OF A RADIOFREQUENCY MASS SPECTROMETER OF THE BENNETT TYPE AT ELEVATED PRESSURES. K. R. Ryan and J. H. Green (New South Wales, Australia. Univ., Kensington). [1963]. 32p.

A study was made of the characteristics of a 9-7 cycle 3-stage nonmagnetic mass spectrometer of the Bennett type. Among the characteristics studied were the ion source collimation, efficiency of the collimating system, resolution, and the effects of trapped electron currents and pressures on the resolved ion current. A comparison is made of the mass spectral patterns with magnetic deflection results. The problems encountered at high pressures are discussed. (D.L.C.)

4056 (NP-13404) DEVELOPMENT OF HIGH-TEMPERATURE CERAMIC RECTIFIERS, THYRATRONS, AND VOLTAGE REGULATOR TUBES. Quarterly Report No. 1, June 26–September 25, 1963. (General Electric Co. Power Tube Dept., Schenectady, N. Y.). Oct. 25, 1963. Contract NAS3-2548. 25p.

A bibliography of pertinent information is presented in the study of vacuum envelopes for high-temperature ceramic diodes, thyratrons, and voltage regulator tubes. Sealing techniques and envelope materials are evaluated. Tests are being performed on the Z-5301 ceramic developmental-type voltage regulator with titanium-rich nickel–titanium alloy seals. A vacuum and gas loading system was revised to investigate voltage regulators at various pressures with different gases. A technique is being investigated for measuring changes in work function of metal substrates when Ba–BaO is deposited as a result of evaporation from the cathode in high-temperature rectifiers and thyratrons. A rectifier test diode is being designed to observe the gas cleanup rate of xenon at frequencies of 400 cycles and above. (R.E.U.)

4057 (NYO-10517(p.153-6)) FIXED ERRORS IN THE RECORDING SYSTEM. T. E. Krogh (Massachusetts Inst. of Tech., Cambridge).

Three strip chart recorders were calibrated by directly supplying various input voltages and reading the output on the chart. The results, plotted as output (in.)/input (mv) vs input were reproducible over several months. Recorder errors can be very significant if accurate ratios are required between peak of quite different heights. Scale factors on three vibrating reed electrometers were measured by supplying voltages directly to the head and measuring the output. Very good agreement with previously measured factors was obtained. (D.C.W.)

4058 (PAN-446/II.IA) METODA PRECYZYJNYCH POMIAROW MALYCH GRUBOSCI I JEDNORODNOSCI WARSTW ORAZ FOLII. (The Precision Method of Measurement of the Thickness and Homogeneity of Fine Layers and Thin Foils). M. Dakovskii, G. Pekakh, M. Sovinskii,

and Ya. Khvashchevskaya (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 14p.

The method of measuring the fine-layer thickness of the order of 1 mg/cm^2 (0.1 to 20 μ) is described. The method is accurate within 0.001 μ. Several methods for the measurement of the homogeneity of these layers are also discussed. (auth)

4059 (TID-19752) INSTRUMENT STANDARDS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 250p. (HWS-10005)

Hanford Atomic Production Operation specification guides for instruments, radiation detection instruments, instrumentation, thermocouples, orifices, process control instruments, and electronic design are presented. Details of this manual are given in TID-4100(Suppl.). (N.W.R.)

4060 (UCRL-7419) ELECTRONIC SYSTEM FOR HIGH-RESOLUTION PULSE-HEIGHT SPECTROSCOPY. Laurence L. Moon (California Univ., Livermore. Lawrence Radiation Lab.). June 24, 1963. Contract W-7405-eng-48. 21p. (CONF-363-1)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

An electronic system that prepares radiation detector pulses for high-resolution pulse-height analysis was developed. The system consists of two units. One is a low-noise preamplifier utilizing nuvistor-transistor hybrid circuitry. The other unit contains the linear amplifier, calibration pulser, and regulated power supply, all using transistor circuitry. Equivalent preamplifier noise ranges from 1300 electrons at 50 pF external input capacity to 10,600 electrons at 1000 pF, measured with 3.9-μsec RC shaping. A system resolution of 27.5 kev, using 2-μsec delay line clipping, was obtained with a 300-mm^2 solid state detector, polonium source, and commercial pulse-height analyzer. The linear amplifier integral linearity is ±0.1% to 10 volts output and has a summing feature to allow simultaneous use of four detectors with appropriate external logic. (auth)

4061 ON THE CALIBRATION OF CASCADE IMPACTORS. T. T. Mercer (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Ann. Occupational Hyg., 6: 1-14(Jan.-Mar. 1963). (LF-1).

The two customary methods of calibrating cascade impactors are compared. It is shown that the method of determining collection efficiency as a function of particle size for each stage provides information for interpreting results in terms of impactor theory, making it possible to establish adequate jet performance. Two criteria are suggested for expressing impactor performance; the root inertial parameter, $\sqrt{\Psi}$, for which collection efficiency equals 0.5 and the slope of the straight portion of the efficiency curve. It is also shown that calibration in terms of the mass median diameter can lead to serious misinterpretation of results. The method of determining the collection efficiency for each stage is shown to be generally preferable for the interpretation of data obtained from sampling unknown aerosols, but both methods have shortcomings which suggest the need for a more refined method of interpretation. (auth)

4062 ELECTRONIC MEASURING AND CONTROL DEVICES FOR NUCLEAR ENGINEERING. Lothar Starke. Kerntechnik, 5: 419-22(Oct. 1963). (In German)

The electronic measurement and control devices for nuclear technology commercially developed in the last few years are briefly reviewed. The types of instruments considered are radiation detectors, recording and evaluation devices, radiation detectors for special purposes, and reactor control and measurement devices using laser beams. The commercial firms supplying these instruments are tabulated. (J.S.R.)

4063 ON THE RESPONSE OF NON-LINEAR TIME-VARIANT CONTROL SYSTEMS SUBJECTED TO A PRE-ASSIGNED SIGNAL IN THE PRESENCE OF GAUSSIAN RANDOM NOISE. Yoshikazu Sawaragi, Yoshifumi Sunahara, et al. (Kyoto Univ.). Tech. Rpt. Eng. Res. Inst., Kyoto Univ., 13: No. 2, 1-14(Mar. 1963).

A graphical method of evaluating the response of nonlinear time-variant control systems excited by a step input in the presence of a stationary random noise is presented. Descriptions theoretically treat various problems. First, in order to motivate the general procedure an extension of the phase plane method is carried out and the indicial response of nonlinear time-variant control systems under the disturbance-free condition is graphically calculated. Second, the non stationary response of nonlinear time-variant control systems with a random input is evaluated by a manner similar to phase-plane analysis. Evaluation of the indicial response of nonlinear time-variant control systems in the presence of gaussian random disturbance is discussed. The advantage of the procedure is applicability to the calculation of response of nonlinear time-variant control systems with various types of pre-assigned inputs, even in the presence of random disturbance. (auth)

4064 SYNTHESIS OF NON-LINEAR CONTROL SYSTEMS WITH A DETERMINISTIC INPUT IN THE PRESENCE OF RANDOM DISTURBANCE. Yoshikazu Sawaragi, Yoshifumi Sunahara, et al. (Kyoto Univ.). Tech. Rept. Eng. Res. Inst., Kyoto Univ., 13: No. 3, 1-49(Mar. 1963).

A technique was established for improving the response of a saturating servo-system subjected to a deterministic input in the presence of random disturbance. To demonstrate this technique, attention is directed to establishing the analytical procedure of the response of nonlinear control systems by means of the statistical linearization technique. First, an analytical method of calculating the equivalent transfer characteristic of a nonlinear element with a deterministic input contaminated by a random disturbance is shown. Second, a graphical technique for evaluating the response of the closed system is developed. Two examples are presented, showing how the behaviors of nonlinear control systems may be analyzed. From these analytical considerations, it is possible to design the intentionally introduced nonlinear controller to optimize the control performance of a saturating servo-system for various input-magnitudes. Detailed discussions for synthetic procedures are given. (auth)

4065 DESIGN AND CONSTRUCTION OF A MODULATED MOLECULAR BEAM MASS SPECTROMETER. R. W. Roberts and P. E. McElligott (General Electric Research Lab., Schenectady, N. Y.). 13p. (CONF-209-9)

From American Vacuum Society Meeting, Boston, Oct. 1963.

A detailed examination of gas-surface interactions requires the accurate measurement and control of many variables. The conbination of ultrahigh vacuum techniques, modulated molecular beams, and mass spectrometry appears to offer a powerful means for investigating these interactions. A small (total volume—1 liter) stainless steel system, consisting of three differentially pumped chambers, was constructed. In one chamber, a solid surface is bombarded with an isotropic flux of molecules. Scattered molecules and reaction products exit through

a slit, are modulated by a vibrating reed, and enter the ionization region of a mass spectrometer. A high signal-to-noise ratio is achieved by phase sensitive amplification of the output of the ion multiplier detector. (auth)

4066 IMPROVEMENTS IN OR RELATING TO RADIO-FREQUENCY PULSE GENERATING CIRCUITS. William Millar (to United Kingdom Atomic Energy Authority). British Patent 940,685. Oct. 30, 1963. Filed Mar. 8, 1961.

A circuit for generating a r-f pulse of constant amplitude is patented. The circuit consists of a tank circuit, having a capacitor, inductor, and spark gap in series, and at least one drive circuit, having a capacitor and inductor connected in series across the spark gap. The resonant frequency of the drive circuit is the same as, or an odd subharmonic of, the resonant frequency of the tank circuit. When the spark gap breaks down, the tank and drive circuits oscillate with the drive-circuit current larger than the tank-circuit current. The currents are in such phase relationship that the resistive losses in the tank circuit are compensated by power transferred from the drive circuit via the spark gap. The amplitude of the pulse is thereby held constant during a portion of the pulse. (M.P.G.)

4067 IMPROVEMENTS IN OR RELATING TO GAUGING MATERIAL PROPERTIES. Frank Maxwell Alexander and Bernard Christie Holben (to Industrial Nucleonics Corp.). British Patent 940,940. Nov. 6, 1963. Filed June 28, 1961.

A reflection thickness gage is described. A standardization method and a unitary mechanism that performs the dual function of a protective shutter and a reflectivity comparison standard whereby the accuracy of the instrument can be maintained by a rapid and efficient automatic procedure are described. A detector is provided for the back-scattered radiation, thus providing a signal indicating a property of the test material. (R.E.U.)

4068 METHODS OF MEASURING WEAK MAGNETIC FIELDS BY NUCLEAR INDUCTION. Georges Bonnet and Antoine Salvi (to Commissariat a l'Energie Atomique). British Patent 941,310. Nov. 6, 1963. Priority date Dec. 23, 1958, France.

The frequency of nuclear precession of the protons in a liquid sample that contains parametric impurities is measured. The line of electronic resonance of the impurity, which exhibits hyperfine structure, is saturated by applying a strong field perpendicular to the field to be measured. The high frequency of oscillation of the electronic resonance greatly increases the polarization of the nuclear spins. A measurable amplitude of the Larmor frequency of nuclear precession is obtained by first applying a h-f a-c voltage to the first of mutually perpendicular windings to produce saturation of the electronic resonance line and then a direct voltage to the second winding to produce a weak polarizing magnetic field. The polarizing magnetic field is then rapidly suppressed, and the second winding is immediately connected to a frequency-measuring instrument. (R.E.U.)

4069 AMPLITUDE ANALYSING SPECTROMETER. Georges Fraysse, Georges Mirat, Yves Pichoff, and Paul Mirat (to Commissariat à l'Énergie Atomique). Canadian Patent 660,198. Mar. 26, 1963. Priority date Oct. 28, 1959, France.

A spectrometer for analyzing the amplitudes of pulses is designed which combines the electronic circuits of an electronic grey wedge spectrograph and an image-retaining cathode ray tube. The spectrometer includes a memory screen (an extremely thin deposit of a dielectric on a very fine metallic grid) disposed between the system of deflection plates and the fluorescent screen. After the image is recorded on the memory screen as a relief charge image, the memory screen image is then read by an electron beam. The dead time can be reduced to less than 1 μsec by using relaxed sweeping. (D.L.C.)

4070 NUCLEAR INDUCTION MAGNETOMETER. Georges Bonnet, Pierre Servoz-Gavin, and Jean-Louis Laffon (to Commissariat à l'Énergie Atomique). Canadian Patent 661,952. Apr. 23, 1963. Priority date July 5, 1960, France.

A nuclear induction magnetometer for measuring small magnetic fields, e.g., earth's magnetic field, is designed which is based on the Overhauser-Abragam effect. This effect, which involves the addition to the liquid sample of a paramagnetic substance having hyperfine structure, enables not only the reduction of the intensity of the auxiliary biasing magnetic field but also the reduction of the duration of application of this biasing field. The magnetometer is designed so that the field is applied on the order of one millisecond, enabling a large number of measurements per minute to be made. (D.L.C.)

4071 BACK SCATTERED RADIATION INSTRUMENT FOR MEASURING THE FLAT WEIGHT OF SHEET MATERIAL. Paul Lippke. Canadian Patent 667,535. July 30, 1963. Priority date Nov. 7, 1959, Germany.

A radiometric instrument is designed for continuously measuring the flat weight and moisture content of a moving web of a sheet material in both longitudinal and transverse directions. The instrument uses back-reflected beta radiation as a measure of the flat weight, and means are provided for urging the instrument surface against the sheet and for automatically removing the instrument upon the occurrence of a major discontinuity in the sheet, e.g., a tear. The instrument comprises a support with a flat guide surface, mounting means urging the guide surface into contact with the sheet, a radiation source with a window in the support, and receiving and indicating means in the support for reflected radiation. (D.L.C.)

4072 SYSTEM FOR AND METHOD OF DETERMINING RANGE. Maurice W. Horrell and Edwin R. Sanders (to U. S. Atomic Energy Commission). U. S. Patent 3,110,025. Nov. 5, 1963.

A system and method for indicating a predetermined altitude of an object or aircraft is described. The device utilizes a pulse transmit-receive system wherein pulses of predetermined width are transmitted towards the ground and the reflected pulses received gating only pulses having a predetermined width. (AEC)

4073 SHIELDING TO CONFINE MAGNETIC FIELD TO ION SOURCE AREA OF A NEUTRON GENERATOR. Adrianus Cornelis van Dorsten and Otto Reifenschweiler (to North American Philips Co., Inc.). U. S. Patent 3,112,401. Nov. 26, 1963. Priority date Sept. 27, 1957, Netherlands.

A neutron generator in which a target plate is bombarded by ions of a hydrogen isotope is described. The ions are formed in a discharge that takes place between two flat plates, one of which is provided with an aperture for the ions produced, serving as a cathode. The discharge is surrounded by a cylindrical anode. An axial magnetic field is provided, which is, in accordance with the invention, completely screened from the acceleration space, the space between the target electrode and the apertured plate. There is no magnetic field in the acceleration space, so that higher acceleration voltages are permissible, since the

reduction of the breakdown voltage by the apparent increase in pressure due to the presence of a magnetic field does not occur in this case. (M.C.G.)

4074 NUCLEAR RESONANCE ABSORPTION APPARATUS. Frank Neville Hosband Robinson. U. S. Patent 3,112,441. Nov. 26, 1963. Priority date Aug. 18, 1959, Great Britain.

A nuclear resonance detecting apparatus is described. The device consists of an electron discharge tube having at least one grid electrode, an anode load circuit for the electron discharge tube, and inductive coil winding for receiving a test sample, a tuning capacitance in shunt across the winding to form a resonant radiofrequency tank circuit. A second electron discharge tube, an anode load circuit for the second discharge tube, and a means for causing operation of the tube as a limiter device to provide a substantially constant amplitude radiofrequency output oscillation at the anode for any amplitude of input radiofrequency oscillation applied across the grid and cathode electrodes of the second discharge tube which is in excess of a predetermined amplitude. A circuit couples the anode and cathode of the first discharge tube to the grid electrode and cathode, respectively, of the second discharge tube. A regenerative feedback connection exists between the anode of the second discharge tube and the grid electrode of the first discharge tube to apply a radiofrequency oscillation of constant amplitude such that the resultant oscillation across the anode and cathode of the first discharge tube is in excess of a predetermined amplitude. (M.C.G.)

4075 APPARATUS FOR PRODUCING NEUTRONS. Joris M. Brinkerhoff, Willard C. Hadley, Victor E. Ragosine, and James W. Shearer (to Lab. for Electronics, Inc.). U. S. Patent 3,113,213. Dec. 3, 1963. Filed Dec. 1, 1959.

An apparatus for producing neutrons by providing a discharge device capable of maintaining a high-voltage glow discharge in a low-pressure atmosphere of deuterium or tritium, or a mixture of both, is described. (M.C.G.)

4076 GUARD RING SEMICONDUCTOR JUNCTION. Frederick S. Goulding and W. L. Hansen (to U. S. Atomic Energy Commission). U. S. Patent 3,113,220. Dec. 3, 1963.

A semiconductor diode having a very low noise characteristic when used under reverse bias is described. Surface leakage currents, which in conventional diodes greatly contribute to noise, are prevented from mixing with the desired signal currents. A p-n junction is formed with a thin layer of heavily doped semiconductor material disposed on a lightly doped, physically thick base material. An annular groove cuts through the thin layer and into the base for a short distance, dividing the thin layer into a peripheral guard ring that encircles the central region. Noise signal currents are shunted through the guard ring, leaving the central region free from such currents. (AEC)

4077 NUCLEAR MAGNETIC RESONANCE APPARATUS. Leslie Kearton Parker (to Perkin-Elmer Corp.). U. S. Patent 3,113,264. Dec. 3, 1963. Filed Jan. 31, 1961.

A method of correlating chart movement with sweep in recording nuclear magnetic resonance is disuussed. The means for effecting the sweep is linked with the means for effecting relative movement, in a direction representing the time axis, between the marker and a support for the chart. (M.C.G.)

4078 IMPROVED ION-PRODUCING MECHANISM FOR CALUTRONS. W. A. Bell, Jr., and W. K. Prater (to U. S. Atomic Energy Commission). U. S. Patent 3,115,575. Dec. 24, 1963.

An ion source for electromagnetically operated equipment for the separation of isotopes, such as the Calutron, wherein a unitized construction is employed to house both the arc chamber and the oven chamber to facilitate assembly and maintenance and to improve operation. (AEC)

Radiation Detection

Refer also to abstracts 4033 and 4627.

4079 (BM-RI-6309) HAZARDS IN USING LIQUID HYDROGEN IN BUBBLE CHAMBERS. Michael G. Zabetakis, Aldo L. Furno, and Henry E. Perlee (Bureau of Mines. Explosives Research Center, Pittsburgh). Dec. 1962. 42p.

An experimental study on liquid and gaseous hydrogen was conducted to determine the hazards associated with the use of liquid hydrogen as an ionizing particle detector in bubble chambers. The glass window, the vacuum chamber, and the vent system were investigated. In addition, a study was made of the detection and ignition of escaping hydrogen and of the available electrical equipment for use in hydrogen atmospheres. Materials such as tempered glass, aluminum, and stainless steel are not penetrated readily by the small fragments formed when fully tempered glass is shattered and propelled by hydrogen at initial pressures up to 100 psig; long, slender fragments from untempered glass may penetrate thin walls of relatively soft materials such as rubber gaskets and lead. Hydrogen can be vented satisfactorily from a vacuum chamber with a well-designed vent system. However, the rapid leakage of hydrogen into the surrounding air is a serious problem because the available detectors are satisfactory only when the accumulation of hydrogen is slow. Much of the electrical equipment currently available was designed for use in hydrogen-air atmospheres. (auth)

4080 (BNL-7310) THE "N" ON "P" SILICON SOLAR CELL GAMMA RAY DOSE RATE METER. A. C. Muller, F. X. Rizzo, and L. Galanter (Brookhaven National Lab., Upton, N. Y.). Aug. 21, 1963. Contract AT-30-2-GEN-16. 23p. (CONF-11-13)

From American Nuclear Society 1962 Winter Meeting, Washington, D. C., Nov. 1962.

The recently developed "n" on "p" type silicon solar cell was evaluated for application as a high-level gamma radiation dose rate meter. The solar cell ionization current was found to be a linear function of dose rate in a range from 10^2 to 10^7 rads per hour. A degradation rate of approximately one per cent per megarad was measured after stabilization with twenty megarads of cobalt-60 gamma radiation. The system was proven to be stable over long periods of time. Temperature dependence corrections were found to be 0.2 per cent per degree centigrade between 0 and 60 degrees centigrade. (auth)

4081 (CONF-16-15) COSMIC RAY CONTRIBUTION TO THE BACKGROUND OF LOW LEVEL SCINTILLATION SPECTROMETERS. Harold May and Leonidas D. Marinelli (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 28p.

From International Symposium on the Natural Radiation Environment, Houston, Tex., Apr. 1963.

Cosmic particles are classified according to principal components, and the major physical processes of interaction and decay giving rise to low-energy photons are discussed. The relative merits of shielding materials such as iron, lead, concrete, and soil for NaI scintillation counters are discussed. (R.E.U.)

4082 (CONF-321-1) A PROGRAMMING SYSTEM FOR SCANNING DIGITIZED BUBBLE-CHAMBER NEGATIVES. Report No. 139. R. Narasimhan (Illinois. Univ., Urbana. Digital Computer Lab.). June 24, 1963. Contract AT(11-1)-1018. 18p.

From Conference on Programming for H.P.D. and Other Flying Spot Devices, Paris, Aug. 1963.

A description is given of the functional characteristics of a program for scanning digitized (raster of black-white dots) bubble-chamber negatives, using an IBM 7090 computer. The emphasis is on the scanning phase, and the input-output features of this phase are discussed. The processing technique for generating the information from the digitized input picture is described briefly. (D.L.C.)

4083 (DPSPU-63-30-13) AUTOMATIC READER FOR DOSIMETER FILMS. J. S. Stutheit (Du Pont de Nemours (E.I.) & Co. Savannah River Plant, Aiken, S. C.). Mar. 1963. Contract AT(07-2)-1. 10p.

An automatic film reader was developed for measuring the density of dosimeter films and computing the gamma and beta-plus-gamma exposures. Exposures up to 1 r and 1 rad can be accurately measured. A unique logarithmic photocell circuit is used to measure the density of the film, and magnetic amplifiers are used to compute the exposures. (auth)

4084 (EANDC-33U) SYMPOSIUM ON THE ABSOLUTE DETERMINATION OF NEUTRON FLUX IN THE ENERGY RANGE 1-100 kev, SEPTEMBER 10-13, 1963, [HELD AT] ST. JOHN'S COLLEGE, OXFORD, UNITED KINGDOM. (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). 171p.

Thirteen papers are included; separate abstracts have been prepared for each. (T.F.H.)

For abstracts of individual papers see: 4085, 4086, 4087, 4088, 4089, 4530, 4531, 4532, 4533, 4534, 4535, 4536, and 4537.

4085 (EANDC-33U(p.25-40)) THE HYDROGEN GAS RECOIL COUNTER FOR NEUTRON FLUX MEASUREMENTS BELOW 100 kev. P. H. White (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

The effects of rounding-off in the high-energy end of the recoil-proton spectrum and of background upon the accuracy of a proton-recoil neutron counter are described. The counter studied is filled with hydrogen gas and is operated in the proportional-counter region. Its accuracy is on the order of 3 to 5% down to about 20 kev. (T.F.H.)

4086 (EANDC-33U(p.44-51)) THE ACCURATE MEASUREMENT OF NEUTRON FLUX BY THE BORON PILE. D. W. Colvin and M. G. Sowerby (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The calibration and accuracy of a boron-pile fast-neutron flux measuring device are reviewed. The pile consists of a cubic graphite lattice, 0.22 m on a side, in which are placed 120 BF_3 counters. (T.F.H.)

4087 (EANDC-33U(p.52-63)) STANDARD CROSS-SECTION FOR NEUTRON FLUX MEASUREMENTS BETWEEN 10 kev AND 100 kev. R. Batchelor and J. F. Barry (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

It is recommended that the $Li^6(n,\alpha)$ reaction be adopted as the primary standard for neutron flux measurement between 10 and 100 kev. The reasoning behind this recommendation is given. (T.F.H.)

4088 (EANDC-33U(p.102-13)) A GREY NEUTRON DETECTOR FOR FLUX MEASUREMENTS IN THE INTERMEDIATE ENERGY RANGE. W. Poenitz and E. Wattecamps (Kernforschungszentrum. Institut für Angewandte Kernphysik, Karlsruhe, Germany).

A quasi-prompt neutron detector based on thermalization of neutrons in a $MnSO_4-H_2O$ mixture and subsequent radiative capture of the thermal neutrons in Mn^{55} is described. The neutron detection efficiency is calculated and the detector is calibrated at thermal energy. This calibration and the smooth variation of the detector efficiency curve enable one to perform neutron flux measurements in the energy range from thermal to 1 Mev. (auth)

4089 (EANDC-33U(p.136-49)) ABSOLUTE MEASUREMENT OF FAST NEUTRON FLUX WITH A LARGE LIQUID SCINTILLATOR. H. Condé, S. Schwarz, and N. Starfelt (Sweden. Försvarets Forskningsanstalt, Stockholm).

A method of making an absolute measurement of the flux of fast neutrons has been studied. An accurately determined fraction of the neutrons in a collimated beam passing along a channel through a large liquid scintillator is scattered into the scintillator. An absolute measurement of the $Li^6(n,\alpha)T$ cross section is made by placing a Li^6-glass scintillator in the calibrated neutron beam. (auth)

4090 (JINR-P-1387) GIDROGAZODINAMICHESKII RASCHET MEKHANIZMA IZMENENIYA DAVLENIYA BOL'SHOI PUZYR'KOVOI KAMERY. (Hydrogasdynamical Calculation of the Pressure Variation in a Bubble Chamber). Yu. A. Budagov, V. P. Dzhelepov, V. G. Ivanov, Yu. F. Lomakin, V. B. Flyagin, and P. V. Shlyapnikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 19p.

A hydrogasdynamical method for calculating the basic parameters of the design of a bubble chamber (and the pressure variation) is described. It was used in developing a 1-meter bubble chamber. A mathematical description of the pressure variations inside a chamber and in a pneumatic system is general enough. For this reason, this method may be applied for calculating different design schemes of practical interest. (auth)

4091 (NIRL/R/41) A PULSED GAMMA-RAY SOURCE FOR TESTING BUBBLE CHAMBERS. R. T. Elliott, J. F. MacEwan, and R. H. Thomas (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). 1963. 11p.

Details are given of a pulsed γ source, designed and built at the Rutherford Laboratory specifically for the British National Hydrogen Bubble Chamber. The source is of general use, however, in testing bubble chambers. (auth)

4092 (PAN-463/IA,II) POWIERZCHNIOWO-BARIEROWE KRZEMOWE DETEKTORY Z PIERSCIENIAMI OCHRONNYMI I MOZLIWOSCI ICH ZASTOSOWANIA. (Silicon Surface-Barrier Detectors With Guard-Rings and Their Possible Applications). Ya. Khvashchevskaya, M. Dakovskii, A. Dombrovskii, M. Sovinskii, and M. Slapa (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Sept. 1963. 16p.

Using a guard ring, the silicon surface-barrier nuclear radiation detectors with a depletion layer thickness about 1 mm were obtained. These detectors were used for charged-particle spectrometry. The resolution for 8.78-Mev α particles was 16 to 20 kev, and the stability was 0.2 to 0.5%/8 hr. By means of a spectrometer using this type

of detector, the energy of α particles up to 50 Mev, of protons up to 12 Mev, of deuterons up to 16 Mev, and β rays up to 700 kev can be measured. In addition, the spectrometer can find use for identification of charged particles. (auth)

4093 (UCRL-7490) A LARGE-VOLUME RADIOMETRIC CALORIMETER. Stuart R. Gunn (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 1, 1963. Contract W-7405-eng-48. 9p.

An isothermal heat-flow calorimeter with a sample chamber of 13-in. diameter and 14-in. length is described. The detection limit is about 1 mW and the precision for large samples is within a few tenths of a percent. A 96-junction thermopile is used for the temperature measurement. (auth)

4094 (FTD-TT-63-579) LABORATORY COURSE ON DOSIMETRIC INSTRUMENTS FOR X- AND NUCLEAR RADIATION. M. Sh. Vaynberg, A. N. Krongauz, R. S. Mil'shteyn, V. I. Tryapitsin, and A. V. Frolova. Translation of "Praktikum po Dozimetricheskim Priboram Dlya Rentgenovskogo i Yadernykh Izluchenii" (a publication of Medgiz, Moscow, 1961). 185p.

A handbook is presented which describes various radiation dosimetric instruments produced in USSR and used in medical practice. Dosimeters and radiometers are described, and auxiliary equipment (radiation filters, phantoms, and pulse discriminators and analyzers) are considered briefly. Also discussed are several laboratory projects to be carried out in completing a course in nuclear physics and dosimetry in medical schools. (D.L.C.)

4095 THE POTENTIAL USE OF LARGE-SURFACE SEMICONDUCTOR DETECTORS FOR α-SPECTROMETRY. V. F. Kushniruk, E. Z. Ryndina, S. M. Solov'ev, and I. I. Chuburkova. At. Energ. (USSR), 15: 324(Oct. 1963). (In Russian)

While the preparation of n–Si type surface-barrier detectors with a specific resistivity of 150 ohm cm is relatively easy, as long as their area is small, the large reverse currents and inhomogeneities in the Si layers prevented the fabrication of detectors with sufficiently large resolving power. However, it was established that an extended lifetime improves the properties of the detectors. A detector fabricated during February 1962 in Dubna for recording α particles and for measuring fission fragment energies and having a resolution of 8 to 14%, was examined 1 and 6 months after completion. It was found that during the intervening time period the reverse current shift decreased by an order of magnitude while the operating voltage increased from 10 to 15 to 150 v; this resulted in a 50-fold improvement in the signal-to-noise ratio and in the resolution of the instrument, allowing the detector to be used not only for recording α particles but also for spectrometric measurements. Use of Si with a specific resistivity of 900 to 1000 ohm cm allowed a 100-μ deep sensitive layer with a resolution of 100 kev to be obtained on a 3-cm^2 surface. (TTT)

4096 ADJUSTABLE CONSTANT POWER SOURCE FOR DIRECT CURRENT IN THE REGION OF 10^{-14} TO 10^{-3} AMPERE FOR TESTING OF IONIZATION CHAMBER AMPLIFIERS. G. Lutz and H. Weiss (Osterreichische Hochschule, Vienna). Atomkernenergie, 8: 350-3(Oct. 1963). (In German)

A constant power source for checking ionization chamber amplifiers and logarithmic amplifiers is described. The use of a pure metal diode as a current source makes continuous adjustment of the current in the range from 10^{-14} to 10^{-3} amp possible and results in a very good long-time stability. The power supply of the diode operating in the saturation range comes from the alternating current network, which renders the unit independent from ageing and servicing of batteries. The diode, including its stabilized power supply, is constructed completely ungrounded so that positive and negative output current as well as serial connection with two other grounded units is possible. Quartz was used as the material for the diode bulb and the mechanical support of the wiring whereby an insulation resistance of approximately 10^{15} ohm and an inner resistance of approximately 10^{15} ohm in the smallest current range could be obtained. (auth)

4097 ON THE 4π β-γ COINCIDENCE METHOD FOR ABSOLUTE MEASUREMENT OF THE DECAY RATE OF RADIOACTIVE ISOTOPES. Gerd Wolf (Max-Planck-Institut für Physik und Astrophysik, Munich). Atomkernenergie, 8: 353-9(Oct. 1963). (In German)

With the 4π β-γ coincidence technique described, it is possible to measure the absolute disintegration rate of suitable radioactive isotopes with greater accuracy than was previously achieved. The principles involved and their limits of application are discussed. Particular emphasis is given to the different technical and physical corrections that were previously investigated. A special application of the method to the measurement of β radiation in a 4π counter is mentioned. (auth)

4098 INVESTIGATION OF THE PARTICLE DISCRIMINATION ABILITY OF VARIOUS ORGANIC PHOSPHORS IN RELATION TO TEMPERATURE AND ENERGY. Eberhard Schwerdtel (Justus-Liebig-Universität, Giessen, Ger.). Atomkernenergie, 8: 359-65(Oct. 1963). (In German)

The particle discrimination ability of stilbene and anthracene in relation to the crystal temperature and the energy of the α and β particles used for stimulating the scintillations is discussed. Stilbene does not depend on temperature but the discrimination capacity of anthracene improves with falling temperatures. For both substances, the discrimination capacity depends on the particle energy. It was concluded that the scintillation pulse shape changes during variations of temperature and energy. The origin of the various pulse shapes during stimulation with α and β particles is discussed. (auth)

4099 EQUIPMENT FOR AN AUTOMATIC DETERMINATION OF THE COUNTING CHARACTERISTICS OF GEIGER-MÜLLER COUNTERS. J. Manca, D. Kollar, and A. Gajdos (Inst. for the Hygiene of Work and Occupational Diseases, Bratislava). Automatizace, 6: 230-1(Sept. 1963).

A device is described for determining the dependence of the number of pulses recorded by the counter on the voltage at a constant radiation intensity. The determination of this characteristic is necessary for supplying the right voltage of the counter. (OTS)

4100 FOCUSING EFFECTS IN TRIPLE-AXIS NEUTRON SPECTROMETERS. M. F. Collins (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Appl. Phys., 14: 805-9(Nov. 1963).

The theory of triple-axis spectrometers is discussed. Expressions are given for peak height and integrated intensities which show that the instrument possesses focusing properties which serve to sharpen line widths and increase peak heights. Five focusing conditions are derived and an operational procedure is suggested to exploit these effects. The use of focusing promises to give considerable improvements in the accuracy of measurements of phonon and magnon line widths. (auth)

4101 LIQUID ORGANIC SCINTILLATORS. V. THE SCINTILLATION AND FLUORESCENCE PROPERTIES OF SOME ANTHRACENE DERIVATIVES. Adam Heller (Israel Atomic Energy Commission, Rehovoth) and Guy Rio. Bull. Soc. Chim. France, No. 8-9, 1707-9(Aug.-Sept. 1963). (In French)

A study was made of the scintillation properties and the fluorescence spectra of solutions of monosubstituted anthracene 9-derivatives and disubstituted 9- and 10-derivatives. Phenylethylnyl-9 phenyl-10 anthracene and 9,10-dicyanoanthracene are suitable scintillators and are usable as secondary solutes because they displace the fluorescence spectra toward the green. (tr-auth)

4102 SOLID STATE IN RADIATION DOSIMETRY. Roman Gonzalez del Campo. Energia Nucl. (Madrid). 7: No. 27, 40-50(July-Sept. 1963). (In Spanish)

The general theory of the operation of solid state radiation detection devices is reviewed. The dosimeters working by coloration, radiophotoluminescence, luminescence decay, thermoluminescence, and radioinduced conductivity are then briefly discussed. The use of cadmium sulfides and selenides and other solid state detectors using the conductivity change and the photovoltaic effect, is described. (J.S.R.)

4103 STUDIES ON SILVER ACTIVATED METAPHOSPHATE GLASS AS A PERSONNEL MONITORING DOSIMETER. Ichiro Miyanaga and Hozumu Yamamoto (Japan Atomic Energy Research Inst., Tokyo). Health Phys., 9: 965-72(Oct. 1963).

Characteristics of high sensitivity, low Z, silver-activated metaphosphate glass were investigated for adequacy as a personnel monitoring dosimeter. Limitation of application and advantages and disadvantages of the dosimeter in comparison with the photographic dosimeter are discussed. Characteristics of photon energy dependence, directional dependence, and linearity between dose and response were quite good in comparison with those of film. Mean error of measurement with a single glass dosimeter could be made to be less than ±5 per cent for γ and x radiation. Fluorescent centers were found quite stable, and the fading was less than 5 per cent in 6 months storage. Cleaning with a synthetic detergent was shown to make the mass handling of the glasses easier in routine operation. For monitoring the accumulated dose of γ radiation, especially for the accumulation of small dosage during a long period, a single glass would be a better substitute for a film badge, both in accuracy and cost. The only disadvantage of the glass dosimeter compared to film badge seems to be in the differential measurements of various kinds of radiation, for it requires more than two pieces of glass, according to the characteristics of the radiation fields. (auth)

4104 THE CALIBRATION OF HEALTH PHYSICS INSTRUMENTS USED TO MEASURE HIGH ENERGY RADIATION. J. Baarli, K. Goebel, and A. Sullivan (CERN, Geneva). Health Phys., 9: 1057-67(Nov. 1963).

Commonly used health physics ionization chambers and personnel monitors were calibrated using high energy radiation from the CERN 600-Mev synchrocyclotron and 28-Bev proton synchrotron. The calibration was done by using the tissue equivalent ionization chamber as reference and exposing the instruments in a 600-Mev proton beam and 400-Mev neutron beam and in the radiation field outside the shield close to the target region of the CERN proton synchrotron. Particle fluxes have been measured with the C-11 induced radioactivity in plastic phosphors. The results are compared with calibration data from the use of Pu–Be neutrons and Ra γ rays for CO_2, air, Ar, and H_2 filled ionization chambers as well as for neutron and gamma film badges and quartz fibre dosimeters. (auth)

4105 CORRECTION OF RADIATION ABSORPTION IN CARRIER FILM DURING BETA EMITTERS STANDARDIZATION IN 4π COUNTER. Josef Klumpar and Miroslava Majerova (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 9: 315-18(Oct. 1963). (In Czech)

The method of correction for beta absorption in the preparation's support used for absolute calibration in 4π counters is described. Thicknesses of the preparation (of the order of hundredths of Mg/cm^2) expressed in equivalent weights of air were determined on the basis of alpha absorption of Po^{210} with the aid of an especially designed device. From the theoretical point of view it is better to use in calculations experimentally gained equivalent weights of air than gravimetrically determined weights since the dependence of absorption on atomic number of the material is included in this manner. (auth)

4106 A SIMPLE CALORIMETRIC METHOD OF X-RADIATION DOSE MEASUREMENTS. Zdenek Kovar (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 9: 319-23(Oct. 1963). (In Czech)

A calorimetric method for direct and absolute measurement of absorbed doses and for calibration of x rays is described. The designed method is feasible with current devices of a physical laboratory, and it is convenient for roentgen apparatus used in roentgen therapy, defectoscopy, or radiation chemistry. (auth)

4107 IONIZATION CHAMBERS TO MEASURE ROENTGEN- AND GAMMA-RADIATION. A. N. Krongauz, A. V. Frolova, and Z. I. Shuligina (State Inst. of Roentgen-Radiological Research Inst., USSR). Med. Radiol., 8: No. 10, 72-7(Oct. 1963). (In Russian)

The necessity of establishing set standards for ionization chambers intended to measure roentgen and gamma radiation is discussed. It is shown that 4 types of ionization chambers will sufficiently serve the medical purposes. The results of research showed optimal correlation between the diameter of the cylindrical chamber and its length to be 0.5–1.0. To effect measurements in the range of effective quanta energies of the order of 10–120 krv, chambers made of therylene and polyethylene with their walls 0.15–0.25 mm thick should be most suitable. (P.C.H.)

4108 A DEVICE FOR MEASURING EXTERNAL RADIATION EMANATING FROM MAN. V. I. Drobotz, K. S. Kalugin, and Yu. M. Shtukkenberg. Med. Radiol., 8: No. 10, 77-82(Oct. 1963). (In Russian)

The design of a device that incorporates a steel protective shield and 8 crystal detecting elements intended for the measurement of external radiation emanating from man is described. The unit has a resolving power of up to 14% for Cs^{137} and up to 10% for K^{40} and traces the presence of Cs^{137} and K^{40} in the human body with an accuracy of up to ±5% during a measuring period of one hour, and also determines the presence of individual gamma-emitters and their mixtures in amounts comprising hundredth fractions of their maximal permissible level in the body. The device is also helpful in tracing hard betta-emitters contained in the body. (auth)

4109 BUILDING OF AN ORANGE-TYPE BETA-RAY SPECTROMETER. Masayuki Goto, Takashi Matono, et al. (Mitsubishi Electric Co., Japan). Mitsubishi Denki Giho, 37: 859-64(July 1963). (In Japanese)

An orange-type beta spectrometer was completed. Relative to this apparatus the principles and general characteristics of beta spectra and also the structure and performance are described. With eight magnets provided around a symmetrical axis, the apparatus has a large available beam angle and a relatively high resolving power as an electromagnet-type spectrometer. The performances of the electromagnet pumping system, radiation detector, and accessories are sufficient to attain a necessary field distribution, high vacuum, and analysis ability. Employment of Cs^{137} makes it possible to obtain complete energy spectra. (auth)

4110 ON THE APPLICATIONS OF THE CALIBRATION METHODS FOR BETA-DOSE DETECTORS. D. Herrmann and C. F. Weiss (Inst. of Applied Radioactivity, German Academy of Sciences, Leipzig). Monatsber. Deut. Akad. Wiss. Berlin, 5: 482-9(1963).

The applicability and limitations of two methods for beta radiation measurements are discussed; the contact measurements by means of an extrapolation chamber and the remote measurements by means of a chamber without solid walls. Both methods use ionized air as a measure of absorbed energy. The effect of the detector sensitivity on the measurement error was analyzed theoretically and the calibration factor was derived. Two situations must be considered; either the detector may be assumed infinitely thin, or its thickness must be taken into account. (OTS)

4111 WIRE SCANNER WITH AUTOMATIC DECAY CORRECTION SYSTEM. Setsuo Kobayashi (Hitachi, Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 854-61(Oct. 1963). (In Japanese)

A wire scanner was manufactured to measure the activities of wires which were irradiated in a reactor core. The detection head of this scanner is a 4π gas-flow counter and is moved intermittently by a partly cogless gear and a servomotor along the wire stretched through the head. The counting time of a wire is controlled by counting the preset number of counts of the same decaying material activated simultaneously with the wire of interest. As the counting continues, the counting interval becomes progressively longer, thus the radioactive decay of the wire being automatically corrected. Main advantages of this timing method are that the data, having been directly corrected, can be presented immediately without any further time correction and that for a given wire the statistics of counting are independent of the time of counting. It was recognized that this wire scanner with automatic decay correction system was very useful in measuring fine structures of the spatial distribution of neutron flux. (auth)

4112 THE EQUIPMENT FOR URANIUM ORE SEPARATION BY RADIOACTIVITY (U-SORTER). Kikuo Takahashi, Keiji Doi, et al. (Atomic Fuel Corp., Tokyo). Nippon Kogyo Kaishi, 79: 597-9(Aug. 1963). (In Japanese)

Equipment was installed at Ningyo-toge Mine to determine the approximate grade of uranium ore by measuring radioactivity and to separate a given grade ore-containing tub from a waste tub. The equipment was composed of eleven Geiger tubes placed at a given distance around the mine tub and of a counting and sorting electrical circuit. The radioactivity from the ore was caught by the tubes and counted by the counting circuit. Consequently, the judgement of go or no-go on the ore is indicated by the sorting circuit. With this device it is possible to measure the radioactivity of all the ore in the mine tub in a short time and to sort the ore and the waste. An experiment using this equipment proved that the grade of uranium ore is correlated to the counts of radioactivity. (auth)

4113 PULSE-TIME DISCRIMINATION AND ITS PRACTICAL USES IN SCINTIGRAPHY. F. Hawliczek and G. Zita (Krankenhauses der Stadt, Vienna-Lainz). Nucl. Med., 3: 312-21(1963). (In German)

An electronic attachment to a scanning machine is described that provides a remarkable improvement in the quality of scintigrams. Using scintigrams recorded on a thyroid phantom and on patients with thyroid or liver disease, the operation and electronic details of the apparatus are explained and the advantages of the method demonstrated and discussed. (auth)

4114 A UNIVERSAL COLLIMATOR WITH ADAPTABLE CONE FOR THYROID RADIOIODINE UPTAKE MEASUREMENTS. TECHNICAL NOTE. Alípio L. Dias Neto (Univ. of São Paulo, Brazil). Nucl. Med., 3: 322-5(1963).

A multi-purpose collimator is described for use in a scintillation detector with a 1-in. × 1-in. NaI(Tl) crystal. The collimator was designed for use in uptake measurements of I^{131} by thyroid. (C.H.)

4115 HIGH-DOSE N_2O DOSIMETER. D. A. Flory (General Dynamics/Fort Worth, Tex.). Nucleonics, 21: No. 12, 50; 52-4(Dec. 1963).

Design and operation of nitrous oxide dosimeters are presented. The readout and calibration, Bragg-Gray requirements, temperature dependence, and neutron sensitivity are discussed. The dosimeter is capable of measuring gamma dose in mixed or pure gamma fields at 10^7 to 5×10^{11} ergs/g carbon. (R.E.U.)

4116 A TRANSISTORIZED RADIATION METER, TYPE MST-2. Józef Kalisz (Office of Nuclear Tech., Warsaw). Nukleonika, 8: 139-43(1963). (In Polish)

The meter consists of a G-M counter and a univibrator, which drives a diode pump; thus, the output voltage of the meter is proportional to the logarithm of the count rate. The proportionality constant is governed by the gradually variable time constant of an RC clipping circuit following the univibrator and of the time constant of the diode pump; both are varied by means of a ganged selector switch to which 3 sets of condensers and a set of bleeder resistors are connected. The output voltage is converted to a current reading by means of an emitter-follower buffer stage and a microammeter; the output of the former is also coupled to 2 Schmitt trigger circuits, each of which may be set at a desired output level from the diode pump. These trigger circuits may be used to indicate 2 separate limits of the output and may thus serve as an automatic control for audible radiation warning devices. The meter may be set at 100, 1000, and 10,000 pulses per second. At its optimum adjustment, the output of the meter is logarithmic within about 3.5%. (TTT)

4117 LIGHT COLLECTION IN SCINTILLATORS. L. N. Averina, B. I. Kerner, R. A. Nikulina, T. I. Sokolovskaya, and Yu. A. Tsirlin. Opt. Spectry. (USSR) (English Transl.), 15: 146-50(Aug. 1963).

Values for the light collection coefficient were calculated for unpackaged, polished, cylindrical scintillators. The computations were compared with experiment by two methods: by simulation and by making use of plastic scintillators exposed to α particles. The results indicate that the calculation takes the basic factors determining light collection in an uncovered scintillator into account. The feasibility of using mockup experiments to determine τ was demonstrated. (auth)

4118 RADIANT INTENSITY DETERMINATION OF PULSED PHOTON BEAMS BY PULSE-HEIGHT MEASUREMENTS. Masakuni Narita, Hiroaki Tanida, et al.

(Hokkaido Univ., Japan). Oyo Buturi, 32: 363-7(June 1963). (In Japanese)

The bremsstrahlung emitted from particle accelerators, such as on electron LINAC, is highly energetic and extremely intense pulse-modulated. It is experimentally verified that commercially available alcohol-quenched G-M counters produce huge pulse heights that are proportional to the intensity of incident pulse-modulated photons by lower applied voltages than the usual G-M starting voltages. By the use of this characteristic, the instantaneous value of radiant intensity for intense pulse-modulated radiations can be determined by pulse-height measurements and their mean value by measurements of starting voltage. This method also may be applied to regulate the operation of the output from nuclear radiation sources. (auth)

4119 EXPERIMENTAL STUDIES OF ENERGY RESPONSE OF FAST NEUTRON DETECTORS. Hatsumi Tatsuta, Yoshikazu Yoshida, et al. (Japan Atomic Energy Research Inst., Tokyo). Oyo Buturi, 32: 367-75(June 1963). (In Japanese)

A 2 Mev Van de Graaff accelerator, fast neutron scintillators, a Hurst-type proportional counter, BF_3 proportional counters surrounded with paraffin of various thickness, and a NaI scintillator surrounded with paraffin were used to examine neutron energy in the range of 5 kev ~ 1.6 Mev. Results are compared for the energy dependence of fast neutron absorbed dose. (auth)

4120 COUNTING-LOSS AND PILE-UP OF PULSES FOR PULSED X-RAY COUNTING. Masao Oshino, Hatsumi Tatsuta, et al. (Japan Atomic Energy Research Inst., Tokyo). Oyo Buturi, 32: 376-80(June 1963). (In Japanese)

Counting loss in dose-rating with a pulse detector is discussed, and the relation of counting loss to average dose rate is clarified. The relation of counting rate to pile-up of pulses in measuring pulsed x-ray spectra is also discussed and a formula is derived for calculating the ratio of the number of signal pulses with no pile-up to that of total signal pulses. (auth)

4121 ENERGY CHARACTERISTICS OF IONIZATION CHAMBER FOR RADIOACTIVE GASES. Zinzo Katoh, Kozo Watanabe, et al. (Japan Atomic Energy Research Inst., Tokyo). Oyo Buturi, 32: 380-4(June 1963). (In Japanese)

Ionization efficiency and energy characteristics of an ionization chamber used for radioactive gases are discussed. Efficiency experiments were made with a chamber 114 mm in diameter and 150 mm in height with walls of stainless steel, using a radioactive point source or Ar^{41}. The efficiency, obtained by varying the position of the source and by using sources of different energies was found to be almost inversely proportional to maximum β energy. The efficiency obtained at 1.20 Mev and that obtained with Ar^{41} are in agreement. As to the energy characteristics, the relation of ionization current vs concentration was investigated. In the range of 0.167 ~ 1.70 Mev, ionization current I was found to be proportional to concentration C in $\mu C/cc$. In comparison with ionization chambers of other dimensions, optimum energy characteristics were evident. (auth)

4122 A QUICK RESPONSE IONIZATION SURVEY-METER. Teruichi Tomura (Hitachi Ltd., Tokyo). Oyo Buturi, 32: 391-7(June 1963). (In Japanese)

A quick response ionization survey-meter and some problems concerned with α contamination are described. To measure small currents a high resistance and a d-c amplifier are used. The time response of such a device was usually improved by the negative feedback, but there is a limitation because of the capacitance parallel to the resistor. This capacitance can be reduced by means of a new device, and the use of a high gain d-c amplifier at the same time makes the response extremely fast. By this method, a time constant less than 0.5 second was accomplished with a resistor of 10^{13} ohms, and 1 mr/h full-scale was realized with a 400-cc air ionization chamber. The response of the device is actually limited by the statistical fluctuations of the ionization current. Theoretical considerations of these problems are discussed and confirmed by measurements using an experimental instrument. Another problem in quickening the response and raising the sensitivity of the survey meter is α contamination. Random pulses or spikes are produced by stray α emitters in the chamber. By analyzing their pulse height distribution, five causes of random pulses are traced, among which the emitters in the wall material, on the walls, and in the air are in the proportion of 55 : 27 : 18. These spikes were reduced to 60% after the chamber was left sealed for one year, and this reduced value is nearly equal to the first figure of the above ratio. When the response is sufficiently fast, the presence of α contamination has no influence on the measurement because recovery to the normal state is fast and the discrimination of these pulses is very easy. (auth)

4123 ANALYSIS OF 10 ~ 100Å REGION X-RAYS WITH A GAS FLOW PROPORTIONAL COUNTER. Hiroshi Okano (Hitachi Ltd., Tokyo) and Takashi Nagatani. Oyo Buturi 32: 398-404(June 1963). (In Japanese)

With an improved gas flow proportional counter and a low noise amplifier, x rays of 10 ~ 100Å were detected and characteristic x ray peaks of O–K, N–K, C–K, B–K, and Be–K were observed. The transmission of the window film used in the counter is 51.4 percent for C–K (43.6Å). The film lasts for longer than one month. The intensities at the mean pulse height are measured as 6,000 cpm for Be–K (pulse height, 10 v), 38,400 cpm for C–K (32 v) under the condition of the electron beam potential of 5 kev and target current of 0.05 μa. The relative standard deviations of the pulse height distribution for the above x rays are also measured. The agreement between theoretical and experimental values is satisfactorily good. When PR-gas is used as the counter gas, the O–K main and its escape peaks are clearly separated, and the energy resolution of smaller than 250 ev in the energy region of a few hundreds ev is expected. Some applications of this system to the electron probe x ray microanalyzer are tried. Qualitative analysis of alumina and quartz and scanning analysis of boron nitride by N–K and graphite by C–K were successfully carried out. (auth)

4124 SPARK COUNTER FOR CONTROL OF α-CONTAMINATION OF EXTERNAL SURFACES OF POLONIUM–BERYLLIUM NEUTRON SOURCES. E. M. Tsenter, M. G. Kosolapov, and V. I. Goleva. Sb. Rabot po Kekotorym Voprosam Dozimetrii i Radiometrii Ionizir. Izluchenii, [No.] 2, 249-57(1961).

The design of a well-type spark detector is described; the apparatus has a geometry near 4π and is used to determine the extent of α-contamination of the external surfaces of Po–Be n surfaces. The chief working characteristics of the counter filled with air and with Ar are given. Recording efficiency for α-particles and n are 3 and 1.1%, respectively, for filling with air, and 12 and 4×10^3% for an Ar atmosphere. The counter is suitable for recording α-particles on an intense β- and γ-background. (Ref. Zh., Fiz. 1963)

4125 DEVELOPMENT OF A 4π SCINTILLATION POSITRON SPECTROMETER AND APPLICATION TO THE MEASUREMENT OF THE POSITRON SPECTRUM IN Y^{88}. Jasper Ivan Rhode. Thesis, Lafayette, Ind., Purdue Univ., 1963. 159p.

A 4π scintillation spectrometer applicable to the measurement of positron spectra was developed. The operation of the system was evaluated in measurements of the positron spectra of Zn^{65}, Na^{22}, and Co^{58} and the negatron spectra of W^{185} and Pm^{147}. It was applied to the measurement of the weak positron transition arising in the decay of Y^{88}. The spectrometer system consists of a 4π beta detector with auxiliary gamma detectors and associated coincidence circuitry. It is necessary to eliminate distortion in the positron spectrum arising from Compton scattered electrons due to the annihilation radiation and to any coincident nuclear gamma radiation. This is accomplished by gating the data-recording device (a multichannel analyzer) to accept and store pulses from the beta detector only when two coincident 511-kev quanta (and perhaps also a nuclear gamma quantum) have been detected. Satisfactory performance of the system was established in measurements of the positron spectra of Zn^{65}, Na^{22}, and Co^{58}, as well as the simple ground-state-to-ground-state negatron transitions in W^{185} and Pm^{147}. In the case of the shapes of the spectra of Zn^{65}, Pm^{147}, and W^{185} good agreement was obtained with previously reported results using magnetic spectrometer systems. The end-point energies for all beta spectrum measurements presented appear to be from 1 to 3% low compared with averages of other reported values. A discussion is presented of certain systematic errors in energy assignments for the calibration lines (arising from summing effects in the 4π geometry), which might account for the low end-point energies. It is pointed out that this problem is connected with the question of the scintillation response of Pilot-B scintillator. The significance of a 20 ± 5-kev positive energy intercept at zero pulse-height for the experimental calibration line is considered in relation to this question. In the measurement of the positron spectrum in Y^{88} as undistorted distribution is obtained by requiring simultaneous detection of the two annihilation quanta and the 1840-kev nuclear gamma radiation that deexcites the level in Sr^{88} to which the positron decay leads. Two measurements of the spectrum yielded experimental shape factors that are consistent with a unique once-forbidden character for the transition. The average end-point energy for the two measurements is 761 ± 9 kev. The results are in good agreement with values of 757 ± 7 and 761 ± 10 kev derived from recent (p,n) threshold measurements. The positron branching was measured and found to be $0.20 \pm 0.01\%$. The log ft is 9.4 and log f_1t is 8.7. From recent gamma intensity measurements in the Y^{88} decay the electron-capture branching to the 1840-kev level was determined to be $5.8 \pm 0.7\%$, which yields an electron capture to positron ratio of 29 ± 4. The log f_1t and electron capture to positron ratio are both in excellent agreement with values that might be expected for unique once-forbidden transitions on the basis of beta-decay theory and nuclear systematics. (TCO)

4126 RADIOMETRICHESKAYA APPARATURYA PRI OBOGASHCHENYA URANOVYKH RUD. (Radiometric Devices for Uranium Ore Enrichment). I. V. Koshelev. Moscow, Gosatomizdat, 1963. 96p.

Descriptions are given of radiometric devices used for sorting and enriching uranium ores. (R.V.J.)

4127 KRISTALL-DIFRAKTSIONNYE GAMMA-SPEKTROMETRY. (Crystal Diffraction Gamma Spectrometers). O. I. Sumbaev. Moscow, Gosatomizdat, 1963. 112p.

A review is given of theoretical and practical aspects of crystal γ diffraction spectroscopy. The operation and characteristics of spectrometers with plane and bent crystals are described, and the resolving power, light power, and line shape are analyzed. Crystal diffraction and the type of crystal diffraction in focusing spectrometers are discussed, and construction parameters of various spectrometers are given. (R.V.J.)

4128 INCREASING THE SENSITIVITY AND PRECISION OF FILM MEASUREMENTS OF GAMMA RADIATION. Allen Brodsky (Univ. of Pittsburgh). 8p. (CONF-67-34)

From Health Physics Society 8th Annual Meeting, New York, June 1963.

More sensitive methods for measuring the optical density of film detection devices are discussed. An optical density amplifier is described. (R.E.U.)

4129 ELECTRONIC TIMING WITH A SOLID-STATE DETECTOR. T. K. Alexander and G. C. Neilson (Univ. of Alberta, Edmonton, Can.). 16p. (CONF-250-9)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Canada, Aug. 1963.

An amplifier and shaping circuit was designed to take advantage of the precise timing available from solid-state particle detectors. The system described is used in the following techniques for nuclear research: (1) fast particle-gamma-ray coincidence measurements using a solid-state detector and a NaI(Tl) scintillation counter; (2) neutron time-of-flight analysis by detecting an associated charged particle for the zero-time reference; (3) prompt identification of charged particles by measuring their energy and velocity simultaneously; and (4) detecting the time of arrival of a pulsed beam of particles from the accelerator. This is done by collecting the nanosecond burst of charged particles in a Faraday cup or on the target itself. (auth)

4130 SOLID STATE NUCLEAR PARTICLE DETECTORS. P. P. Webb (RCA Victor Co., Ltd., Montreal). 28p. (CONF-310-1)

From Symposium on Physics and Nondestructive Testing, San Antonio, Oct. 1963.

A general theoretical background is given for this review. Diffused-junction, surface-barrier, lithium-drifted, and conductivity counters are discussed. Applications are given, together with energy resolution, range of linearity, pulse rise times, window thickness, and the present limitations of each type. (auth)

4131 RADIATION-SENSITIVE PICKOFF AND RESOLVER. (to Lear, Inc.). British Patent 940,790. Nov. 6, 1963. Priority date June 30, 1960, United States.

A gyroscopic device is described that makes use of radiation-sensitive elements which detect an unbalance through their electrical properties. A pendulum-mounted radiation source is used to determine which elements are irradiated, and the corresponding electrical stimulation is detected by proper means. The apparatus is arranged to detect rotations in a first coordinate system in terms of components in a second coordinate system. (R.E.U.)

4132 DEVICES FOR DETECTING AND IDENTIFYING RADIOACTIVE ELEMENTS, IN PARTICULAR FOR GEOPHYSICAL PROSPECTION. Jean Guitton and Claude Lallemant (to Commissariat à l'Énergie Atomique). Canadian Patent 658,926. Mar. 5, 1963. Priority date Apr. 10, 1959, France.

A device is designed for detecting and identifying two gamma-emissive elements, e.g., U and Th, in aerial and land prospecting. The device comprises a single detector and several discriminators having wide energy bands. The device traces two curves simultaneously on a paper strip; one curve gives the total radioactivity while the other curve detects the preponderant gamma-emissive element. (D.L.C.)

4133 GEIGER-MULLER TYPE RADIATION DETECTOR CIRCUIT. Reinhard Schneider. Canadian Patent 667,089. July 23, 1963. Priority date Jan. 26, 1959, Germany.

A small, portable radiation detection instrument is designed which is economical to make and gives an extremely wide range of measurement, e.g., 5 μr/hr to 100 r/hr. The instrument comprises a filter, a detector for the filtered radiation, an amplifier for amplifying and shaping the detector output, an integrator for the amplifier output, an indicator, and a high-voltage oscillator power supply. A range change mechanism is provided so that, when the detector delivers a low pulse count output, the integration takes place with a large time constant and wide pulse width and the power supply consumption is reduced, while for high pulse count output, the integration time constant and pulse width are small and the power supply consumption is increased. In the most intense radiation ranges, the detector is made to conduct only in intermittent periods. (D.L.C.)

4134 ELECTROCHEMICAL RADIATION DOSIMETER. Edmund J. Casey and Ian H. S. Henderson (to Minister of National Defence). Canadian Patent 667,105. July 23, 1963. Filed Oct. 24, 1960.

An electrochemical radiation dosimeter is designed which can be used in the field and whose redox reaction is reversible. The dosimeter comprises two half cells joined by an electrolyte and separated by an electrolytically conductive diaphragm. One of the half cells is a reference electrode, while the other comprises a sealed fluid-impervious nonconducting chamber with an electrolyte and an associated redox material therein, and an electrode operatively associated with the electrolyte and including an exterior connection. When the two half cells are connected externally through a meter, radiation manifests itself by changing the meter reading. The change may be reversed by passing a current through the electrode in the sealed chamber. (D.L.C.)

4135 NUCLEAR RADIATION DETECTION DEVICE. Walter Shriner. U. S. Patent 3,112,400. Nov. 26, 1963. Filed Dec. 5, 1961.

An instrument for visually indicating the presence and relative intensity of ionizing radiation is described. The device consists essentially of an inner chamber defined by an electrically nonconducting inner wall, which is insulated from surrounding electrostatic influences by a wall of dielectric material spaced from and surrounding the inner wall. The end walls are sealed thereon so as to define an outer chamber that confines an insulating body of ionizable gaseous medium such as air and/or a hydrocarbon gas not miscible with water that is in flow communication within the inner chamber. Free-floating elements of a material suitable for retaining an electrostatic charge are confined in the inner chamber. The device is charged by being agitated in a manner to distribute the elements around the interior of the inner wall. If ionizing radiation is present, the electrostatic charge on the inner wall and elements is reduced in proportion to the quantity of the ionizing radiation that has penetrated the body of ionizable medium and reached the inner wall. (M.C.G.)

4136 NEUTRON DETECTOR OF CRYSTALLINE BORON PHOSPHIDE. Dale E. Hill (to Monsanto Chemical Co.). U. S. Patent 3,113,210. Dec. 3, 1963. Filed Oct. 27, 1960.

A neutron detector using crystalline rhombohedral boron phosphides having a boron-to-phosphorus ratio of at least 6 to 1 as the sensing element is described. The preparation of boron phosphides is discussed and 9 examples are given. The boron phosphide gives a varying resistance in accordance with the radiation flux to which it is subjected. High-melting-point conductors are attached to the boron phosphides and make ohmic contact. Electric leads are attached to the conductors and associated circuitry. (M.C.G.)

4137 HIGH AND LOW LEVEL RADIATION METER. Thomas A. Weil (to Twinco, Inc.). U. S. Patent 3,113,212. Dec. 3, 1963. Filed Dec. 4, 1961.

A radiation meter that will provide an instantaneous determination of both relatively high and relatively low radiation levels is described. The meter incorporates a tube responsive to radiation, such as a Geiger-Mueller tube, within an integrating circuit wherein the average current is measured, rather than the counting rate. The Geiger-Mueller tube is also incorporated in a current multiplication circuit for measurement of low radiation levels. (M.C.G.)

ISOTOPE TECHNOLOGY

Industrial Applications

Refer also to abstract 3933.

4138 (TID-19206) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. Annual Report, February 1, 1962–January 30, 1963. (California. Univ., Davis and California. Univ., Riverside). Contract AT(11-1)-34. 181p.

The effectiveness of radiation processing in extending the storage life of fruits and vegetables was investigated. Preliminary results are reported on the effects of various treatments combined with γ irradiation at various dose levels on the flavor, texture, chemical composition, water loss, and general post-irradiation storage properties of lemons, oranges, strawberries, pears, asparagus, tomatoes, papayas, pineapples, peaches, nectarines, and grapes. The effects of internal atmospheres and ozone on radiation injury of fruits and the radiosensitivity of fungi involved in fruit spoilage were also investigated. (C.H.)

4139 APPLICATION OF γ-RADIATION SOURCES FOR FLAW DETECTION AT THE CSEPEL (HUNGARY) METALLURGICAL PLANT. E. Fenveshi, K. Shcherbak, and K. Bara. At. Energ. (USSR), 15: 351-3(Oct. 1963). (In Russian)

Following development work, γ sources became widely used in Hungary for inspection of weldments and castings. About 40,000 to 42,000 gammagraphs are taken every year, half of them at the Csepel Plant, using Co^{60}, Cs^{137}, and Ir^{192} sources obtained from Great Britain and the Soviet Union. The Radioisotope Laboratory is housed in its own 100-m^2 building, provided with interlocked doors and with automatically controlled removal of the sources; the operating personnel is thus carefully protected. The sources are kept in special storage wells; large castings are placed directly over these wells; for the inspection of small goods, a special spherical source is used. In addition, portable sources are available for on-site inspection. The sources were also used for checking old, reinforced-concrete buildings by determining the exact location of the reinforcing rods. This type of examination was found useful in the current reconstruction of the Budapest citadel. (TTT)

4140 MEASUREMENT OF MOISTURE IN RAW MATERIALS FOR MAKING PIG IRON BY NEUTRON SLOWING DOWN. Hiroshi Iijima and Yoshio Miyasita (Nippon Kokan Co., Japan). Nippon Kokan Giho, No. 26, 90-100(May 1963). (In Japanese)

An attempt was made to develop a method for measuring moisture in raw materials for making pig iron (sinter mixture, coke, and iron ore). It was concluded that this method could be put into practical use. As a result of examinations of the volume, bulk density, chemical components, and grain distribution as primary factors that exert influences on the measurement, bulk density was revealed to be of primary importance. The phenomenon of neutron slowing down was analyzed by means of Fermi theory. (auth)

4141 SPRAVOCHNIK PO RADIOIZOTOPNYM PRIBORAM DLYA KONTROLYA I AVTOMATIZATSII TEKHNOLOGICHESKIKH PROTSESSOV. (Handbook on Radioisotopic Instruments for Control and Automation of Technological Processes). L. I. Korotkov. Moscow, Gosatomizdat, 1963. 236p.

A comprehensive review is given of various radioisotopic instruments for control and automation of technological processes. Descriptions of relay type devices, content gages, and instrument for measuring thickness, density, pressure, and humidity are included. (R.V.J.)

Separation and Production

4142 (MND-P-2977) PRODUCTION OF STRONTIUM–TITANATE RADIOISOTOPE FUEL FOR SNAP 7B THERMOELECTRIC GENERATOR. Justin L. Bloom (Martin-Marietta Corp. Aerospace Div., Baltimore). Apr. 15, 1963. Contract AT(30-1)-3062. 92p.

The conversion of strontium-90 to strontium titanate heat source pellets is described. Encapsulation of the fuel in Hastelloy C containers and necessary leak testing, decontamination and calorimetry procedures are covered. Loading of the SNAP 7B thermoelectric generator was accomplished. (auth)

4143 (NP-13340) POSIBILIDADES ARGENTINAS PARA LA PRODUCCION DE AGUA PESADA. Informe No. 90. (Possibilities for the Production of Heavy Water in Argentina. Report No. 90). Enrique Silberman and Ruben F. Cretella (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1963. 38p.

As an introduction to the problems in the industrial production of heavy water, the industrial plants in operation are briefly described, and the causes determining their evolution are discussed. The industrial methods studied in England, France, Germany, Sweden, Switzerland, India, Egypt, Japan, and O.E.C.E. for the production of D_2O are summarized. The market for heavy water is discussed. The factors considered in the selection of the production process to be developed for Argentina are given, and the cost of a H_2S–H_2O exchange installation is determined. The cost of such a plant modified for Argentine needs is then analyzed. It is concluded that the combination of the H_2S–H_2O process in a single unit with integral energy supply, coupled with the elimination of auxiliary installations, results in a considerable reduction in operation costs and plant investment, as compared with the cost of the process in the U.S. The plant construction plan is summarized. (J.S.R.)

4144 (AEC-tr-6129) IMPROVED DEVICES FOR SEPARATING GASES BY DIFFUSION. Y. Duriau, M. Gadal, and P. Pecqueur. Translated from Belgian Patent 567,135. Oct. 25, 1958. 12p.

A device is described for the separation of gases of slightly differing molecular weights by diffusion through at least one porous wall. The device is characterized by the fact that it comprises at least one bundle of porous diffusion tubes mounted on a support in parallel, and connecting an inlet collector of gas to be diffused with an outlet collector for the evacuation of residual gas. The tube bundle is located in a jacket delimiting a space insulated in a tight manner from the inlet and outlet collectors, the space serving for the collection of the fraction of gas diffused through the porous tubes. (P.C.H.)

4145 PLATE BY PLATE CALCULATIONS OF MULTICOMPONENT DISTILLATION COLUMNS USING DIFFERENCE EQUATIONS. I. IDEAL CASCADES AND CONSTANT FLOW COLUMNS OPERATING AT TOTAL REFLUX. Z. Fraenkel (Weizmann Inst. of Science, Re-

hovoth, Israel), A. Raviv, and W. Klein. Chem. Eng. Sci., 18: 697-709(Nov. 1963).

Description is given of plate-by-plate calculations of separation columns using finite difference equations. The calculations were performed on the WEIZAC digital computer. The purpose of the calculations was essentially twofold: comparison of various ideal cascades among themselves and with constant flow cascades; and preparing a series of graphs from which the behavior of a given column with given input parameters can be predicted a priori. In addition, the results of the methods are compared with the results of calculations based on the solution of differential equations for one system for which such a solution is available. The calculations are also compared with experimental results on fractional distillation and thermal diffusion columns. (auth)

4146 *THE SEPARATION OF STABLE ISOTOPES.* Chen Wan. Hua Hseuh Tung Pao, No. 8, 10-20(1963). (In Chinese)

The methods used for the separation of stable isotopes are reviewed. They include methods based on the difference in the mass of the isotopes, such as electromagnetic and centrifugal methods; on molecular kinetic characteristics, e.g., diffusion, thermal gradient, molecular distillation, and electrophoretic methods; on thermodynamic properties, such as distillation, chemical exchange, chromatographic, absorption, crystallization, and extraction methods; on chemical reaction kinetics of the isotopes, for example, methods based on the kinetic isotopic effect, photochemical properties, and electrolysis. A fifth class, the method based on biological effects, is also reviewed. Industrial use of these theoretically possible systems depends on the relative physical properties of isotopes considered, such as the relative volatility of given compounds. Energy requirements and capital costs determine the cost of industrial methods, among which are those relying on gaseous diffusion, centrifugation, distillation, and chemical exchange. Electrolysis is suitable for both small, and large-scale separation of lithium and hydrogen isotopes. The electromagnetic method is of interest for separating microamounts of isotopes regardless of the atomic weight involved. Diffusion and centrifugation are considered as most suitable for the separation of isotopes of heavy elements and chemical exchange and distillation for those of light elements. (19 references) (TTT)

4147 ISOTOPIC FRACTIONATION OF CARBON BY MOLECULAR DISTILLATION. Ryohei Nakane and Toshiyuki Ohyama (Inst. of Physics and Chemical Research, Tokyo). Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 7-9(Mar. 1963).

Carbon-13 was concentrated by molecular distillation of methyl alcohol at −95°C. The apparatus used is a Dewar vessel type still consisting of two glass vessels, one within the other. Methyl alcohol evaporates in the outer vessel and freezes on the chilled inner vessel. The distillation is operated with various cuts from 8 to 145 and the enrichment factor from 1.02_2 to 1.04_8 yielding concentrated carbon-13 in the residue. On the assumption that the vapor pressures of isotopic methyl alcohols are the same, the single-stage separation factor is determined to be 1.01_6 and the efficiency about 60 percent. (auth)

4148 METHODS AND APPARATUS FOR PRODUCING DEUTERIUM BY DISTILLATION OF HYDROGEN. Léon Stouls (to Commissariat à l'Énergie Atomique). Canadian Patent 660,349. Mar. 26, 1963. Priority date May 2, 1960, France.

A modified apparatus is designed for producing D_2 with very little tritium contamination. The apparatus comprises two double distillation columns, one of which is the preconcentration column and the other's lower column is the final column. The final column is provided with a large number of theoretical plates, e.g., more than 40, so that there is a zone where the enrichment in D_2 is practically maximum while that in T_2 has not yet begun, and the D_2 product is withdrawn from this zone. Similarly, the upper column of the preconcentration column has a large number of theoretical plates, and HD is withdrawn from the zone where the HD enrichment is practically maximum and the HT enrichment has not yet begun. The withdrawn HD is made to undergo a catalytic reaction to transform all its HT into HD and DT which are easier to separate from D_2. (D.L.C.)

4149 PROCESS FOR THE ISOTOPIC ENRICHMENT OR FRACTIONATION OF HYDROGEN. Fernande Botter, Grégoire Dirian, Henri Sack, and Bernard Lefrançois (to Commissariat à l'Énergie Atomique and Houillères du Bassin du Nord et du Pas-de-Calais). Canadian Patent 664,835. June 11, 1963. Priority date Aug. 28, 1959, France.

A process for the isotopic fractionation of hydrogen by electrolysis of liquid ammonia is described which gives deuterium separation factors of 15 to 30. The high separation factors are obtained by using acid electrolytes (e.g., NH_4Br), low temperatures, and/or metal cathodes. Two electrolytic cells for carrying out the process are described, one for use at atmospheric pressure and the other at high pressures. (D.L.C.)

4150 ULTRACENTRIFUGES FOR THE SEPARATION OF A GASMIXTURE IN TWO COMPONENTS. Jaap Wind and Johannes Los (to Reactor Centrum Nederland). Canadian Patent 665,505. June 25, 1963. Priority date Dec. 27, 1957, Netherlands.

A continuously operating ultracentrifuge for the separation of gaseous isotopes is designed which avoids the difficulties usually encountered with centrifuges having axle bearings. The ultracentrifuge comprises an oblong tubular rotor drum supported at the bottom by a point bearing and at the top by magnetic forces. The magnetic forces are produced by a magnetic field and two rings of magnetic material, one of which is attached to the top of the drum, and roomy tubes for conducting gas into and from the drum are passed through the rings. Resilient and damping means are provided to permit the drum to attain supercritical speed easily. (D.L.C.)

4151 DEVICES FOR THE SEPARATION OF FLUIDS BY DIFFUSION THROUGH A POROUS WALL. Jean H. Bertin, Benjamin Salmon, and Lucien Guillaume (to Commissariat à l'Énergie Atomique). Canadian Patent 665,641. June 25, 1963. Priority date Feb. 15, 1960, France.

A gaseous diffusion cell device for isotope separation is designed with means for creating turbulence in the gaseous stream and thus increasing the contact of the stream with the porous wall. The means may comprise obstacles and/or jets of auxiliary fluid. Several embodiments of the device are described. (D.L.C.)

4152 METHOD OF RECYCLING A CATALYST USED FOR ISOTOPE EXCHANGE. Hans Jaenicke and Siegfried Walter (to Friedrich Uhde GmbH). Canadian Patent 672,391. Oct. 15, 1963. Filed Jan. 22, 1962.

A method is given for recycling catalyst in a deuterium production plant which utilizes chemical exchange between hydrogen and water. In this method, after the catalyst has been separated as a concentrated suspension from the exchanged water, the catalyst is caused to undergo isotope

exchange in a hot column with hydrogen depleted in deuterium, so that the enriched water adhering to the catalyst is returned to a normal deuterium content. The catalyst can then be added to the top of the isotope exchanger. (D.L.C.)

4153 METHOD OF RECYCLING A CATALYST USED FOR ISOTOPE EXCHANGE. Hans Jaenicke and Siegfried Walter (to Friedrich Uhde GmbH). Canadian Patent 672,392. Oct. 15, 1963. Filed Jan. 22, 1962.

A method is described for recycling a catalyst in a deuterium production plant using isotope exchange between hydrogen and water. The method minimizes in a simple way the detrimental effects of the adhering enriched water in the catalyst on the plant efficiency. In the method, the isotope exchanger is subdivided into several columns, and the catalyst is withdrawn in concentrated form from each of the columns and returned to the top of the same column. Before entering the top of the column, the catalyst is mixed with the water coming from the preceding column. The difference in deuterium contents in the incoming water and in the adhering water of the catalyst is reduced when the number of columns is increased. (D.L.C.)

MATHEMATICS AND COMPUTERS

4154 (BNL-7396) A TIME-SHARED COMPUTER DATA COLLECTION SYSTEM AT THE BROOKHAVEN GRAPHITE RESEARCH REACTOR. R. E. Chrien, S. Rankowitz, and R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). Sept. 30, 1963. Contract AT(30-2)-GEN-16. 10p. (CONF-346-1)

From International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963.

The on-line system for simultaneous data collection from two physically unrelated neutron time-of-flight experiments is described. A transistorized, digital computer with a 2048, 24 bit word memory provides 1024 and 256-channel time analyzers, clocks, and total events and monitor scalers for fast and slow neutron chopper experiments, respectively. (D.C.W.)

4155 (HMI-B-30) EINFUHRUNG IN DIE DISTRIBUTIONSTHEORIE. (Introduction to the Distribution Theory). F. Stummel (Hahn-Meitner-Institut für Kernforschung, Berlin). Aug. 1963. 74p.

Basic concepts and definitions according to the models of L. Schwartz and Gelfand-Schilow are presented. The theory of periodic distribution in $K'(R^1)$ and the uses of this theory, especially for the representation of generalized functions such as derivation of continuous functions, for the generalized boundary-value problems in the potential theory for a sphere, and for solution of initial-value problems for the wave equation according to the Fourier method in the distribution theory are discussed. The folding of generalized functions for the case of periodic distributions was considered. Thirty-nine example problems are given. (M.C.G.)

4156 (TID-19721) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. SWITCHING THEORY. PART V. IBM 7094-1401 SYSTEM. PART VI. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Aug. 1963. Contract AT(11-1)-415. 34p.

Attention is devoted to: high-speed computer construction; use of Illiac II; computer-circuit and switching studies; program descriptions for the IBM 7094 and 1401 computers; and the operations and problems solved by these computers. (T.F.H.)

4157 (TID-19785) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. IBM 7094-1401 SYSTEM. PART V. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Sept. 1963. Contract AT(11-1)-415. 46p.

The development, operation, and programing of the University of Illinois computer system are summarized. Information is included on component testing, ILLIAC II system programing and operation, development of photo-coupled tunnel-diode circuits, characteristics of laser diodes, investigation of microplasms in transistors nearing the avalanche mode, computer program specifications, and operation data. (N.W.R.)

4158 NUMERICAL CALCULATIONS BY THE HELLMANN–FEYNMAN PROCEDURE. L. Salem and M. Alexander (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 39: 2994-6(Dec. 1, 1963).

Simple calculations of atomic forces and of force constants in homonuclear diatomics confirm the unreliability of the Hellmann–Feynman procedure for calculating molecular forces unless very accurate one-electron densities are used. Electronic forces are extremely sensitive to polarization and to small density changes near atomic centers, so that in general they cannot be used alone to determine accurately a totally a priori one-electron density. They may, however, be useful in testing the features of the density obtained from a variational wavefunction. (auth)

4159 FOR NUCLEAR-PARTICLE ANALYSIS—COMPUTERS OR MULTICHANNEL ANALYZERS? Robert J. Spinrad (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 21: No. 12, 46-9(Dec. 1963).

A general discussion is set forth on the replacement of multichannel analyzer systems by digital computers. The advantages of such digital computers are discussed. Some existing systems and disadvantages of such systems as well as their effects on scientific research techniques are discussed. (R.E.U.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 4765, 4795, and 4796.

4160 (BNL-799(p.74-100)) METALLURGY DIVISION. D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.).

Severe corrosion penetration occurred in the fusion line of the condenser weld in a Zr-pretreated boiling Hg loop. Analysis of the failed Nb–1 Zr loop containing boiling Hg showed Si to be associated with the cracks. Slight corrosion of Nb and Nb–1 Zr alloy by Na and Na vapor at 1210°C was observed in reflux capsules. Apparatus for the determination of small amounts of O in Na by an isotopic dilution method is being built. The first high velocity boiling Na loop was assembled and is being installed in its vacuum chamber. A coupon of Dy_2O_3 dispersed and clad in SS has received 1.4×10^{21} nvt in MTR without appreciable dimensional change. Results were obtained on the effect of time, temperature, and composition of a liquid alloy on electrodiffusion. The effect of Fe on the thermopower of liquid Bi was found. A small, but measurable, potential of a liquid metal cell was found. The solubility of Ti in Hg was measured. The effect of irradiation on the parameter for the Petch equation for the yield stress in Fe and Fe–C alloy was measured. A new apparatus was developed for electrothinning Fe specimens for electron transmission microscopy. In irradiated graphite, the gross growth, C-axis, stored energy, and electrical resistivity all decrease with increased annealing frequency, while the thermal conductivity and absolute value of the Hall coefficient at −194°C increase. Measured oxidation rates of irradiated periodically annealed graphite are lower by a factor of 1.3 to 5 than oxidation rates of unirradiated graphite samples of the same type. The single interstitial migration energy can be determined from stored energy and thermal resistivity change in irradiated graphite. The annealing function obtained can be used to determine the relative contributions of the defects and is sufficiently sensitive to distinguish vacancy effects that are an order of magnitude less than interstitial effects. The rate of absorption of Br by pyrolytic graphite is strongly dependent upon the surface area perpendicular and nearly independent of the surface area parallel to the graphite planes. I_2 is both chemisorbed (~1%) and physically adsorbed (~99%) on graphite. The temperature range of measurements of the diffusion of Xe from UC was extended to 1625°C. Investigations were initiated on Zr–U–C fuel systems. Metallographic analyses of a weld failure in the HFBR vessel neck, Nb–1 Zr Na corrosion capsules, imperfections in 316 SS pipe, and cracking in a platinum reaction vessel are described. (auth)

4161 (GEAP-4351) MATERIALS FOR SUPERHEAT FUEL SHEATHS. RELATIVE PERFORMANCE OF ALLOYS IN SUPERHEATED STEAM ENVIRONMENTS. F. A. Comprelli, D. F. MacMillan, and C. N. Spalaris (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1963. Contract AT(04-3)-189. 95p.

Experiments were conducted to obtain relative comparisons of alloy behavior in actual and simulated nuclear superheated steam environments. These studies were undertaken in order to select a sheath material or a group of materials for further study and possible use in the design and fabrication of fuel elements. The investigations included: (a) study of radiation effects upon the tensile properties of the alloys, (b) corrosion behavior in the absence and presence of stress, (c) effect of prolonged, high temperature exposures upon structure sensitive properties of the alloys, and (d) physical metallurgical changes as a function of exposure in a superheat environment. Analysis of the comparative behavior in these tests established a firm basis for selecting alloys for further study "in depth." In addition, the results were partially instrumental in selecting the alloys for fuel sheaths and for preparing the material specifications for the ESADA-VESR Mark II Core. (auth)

4162 (HW-68600-26) PLUTONIUM ABSTRACTS. Volume 3, No. 4. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1, 1963. Contract AT(45-1)-1350. 6p.

A total of 10 references in abstracted form is presented on new developments in all areas of plutonium technology. The references are arranged according to the topics chemistry, metallurgy and ceramics, and physics. (D.L.C.)

4163 (HW-68600-27) PLUTONIUM ABSTRACTS. Volume 3, No. 5. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1, 1963. Contract AT(45-1)-1350. 7p.

A total of 18 references in abstracted form is presented on new developments in all areas of plutonium technology. The references are arranged according to the topics biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and reactor technology. (D.L.C.)

4164 (HW-SA-2453) PLUTONIUM AND URANIUM CERAMIC FUELS. I. D. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 19, 1962. Contract AT(45-1)-1350. 40p.

A review is presented of the fabrication, ex-reactor properties, and in-reactor performance of Pu and U ceramic fuel materials, with the emphasis on research performed at Hanford, particularly on non-sintered packed-particle fuels. Some of the results of irradiation tests on packed-particle fuel elements and on defected fuel elements are given. The fission product distribution in irradiated fuel elements is discussed. It is concluded that prototype PRTR fuel elements are performing satisfactorily under irradiation. (D.L.C.)

4165 (IS-567) GROWING OF BISMUTH SINGLE CRYSTALS. Bruce K. Long, Ed Olson, and Morton Smutz (Ames Lab., Ames, Iowa). Aug. 1962. Contract W-7405-eng-82. 42p.

The soft mold technique was used to grow single crystals of bismuth by lowering molten bismuth at a controlled rate in a Bridgman furnace. There appeared to be no relationship between the rate of lowering or the amount of supercooling on the probability of growing a single crystal. The measured electrical resistivity was found to be related to the observed orientation by the function $\rho_\theta = \rho_{||} \cos^2\theta + \rho_\perp \sin^2\theta$ where $\rho_{||}$ and $\rho_\perp$ are the resistivities parallel to and perpendicular to the c axis and θ is the angle between the sample axis and c axis. (auth)

4166 (MLM-1171) REACTOR FUELS AND MATERIALS DEVELOPMENT— PLUTONIUM RESEARCH, JULY–SEPTEMBER 1963. L. J. Wittenberg (Mound Lab.,

Miamisburg, Ohio). Sept. 30, 1963. Contract AT-33-1-GEN-53. 20p.

Progress is reported on the determination of fundamental information of Pu-containing materials. The information is divided into three areas: the physical and thermal properties of fuel systems, Pu alloy phase equilibria, and the formulation of Pu-bearing ceramic systems. The phase studies included the Pu–Y, Pu–Ce–Ni, and Pu–Ce–Cu systems, and improvement of Ce purity. The physical properties included the density of Pr, the viscosity of molten Pu–Fe and Pu–Ce–Co alloys, and the vapor pressures of Cd and Zn. The Pu ceramic studies included the examination of PuO_2 microspheres produced in a plasma torch and the preparation of Pu-containing glass spheres. (D.L.C.)

4167 (NAA-SR-7544) DEVELOPMENT OF FERRITIC STEELS FOR HIGH TEMPERATURE SODIUM SERVICE. PART II. W. J. Anderson, G. S. Sheffield, and A. J. Birkle (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 30, 1963. Contract AT-11-1-GEN-8. 63p.

The suitability of modified 2.25 Cr–1 Mo alloy steels for sodium service was investigated. Eleven modifications were examined to establish heat treatment behavior, mechanical properties, resistance to decarburization in liquid sodium, and weldability. Two of the alloys, 4S8 (2.25 Cr–1 Mo–0.6 V–0.1 Cb) and 4S4 (2.25 Cr–1 Mo–0.6 V), were found to have the best combination of properties. When heat treated by normalizing and tempering, their mechanical properties to 1200°F were found to be comparable to those of Type 304 stainless steel. A low chromium, nickel-base alloy was developed for welding the steels, to give either fully heat treatable joints or to apply the butter-weld technique useful in field welding. It provides high joint efficiency without sacrifice in joint ductility. (auth)

4168 (NIRL/R/45) THE PRODUCTION OF THIN HYDROGEN-FREE CARBON TARGETS. P. Ford (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). June 1963. 11p.

A description is given of the methods and apparatus used to obtain thin hydrogen-free carbon targets for proton-proton scattering experiments, using the polythene-carbon difference method. (auth)

4169 (NP-13393) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Mary F. Banks, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Oct. 1963. Contract AF33 (616)-7747. 62p.

A total of 83 references in abstracted form are presented on subjects within the technical scope of DMIC. They are arranged according to high-strength alloys, light metals, nonmetallics, refractory metals, and miscellaneous (coatings, applications, and composites). Author and subject indexes are included. (D.L.C.)

4170 (ORNL-3470) METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1963. (Oak Ridge National Lab., Tenn.). Nov. 11, 1963. Contract W-7405-eng-26. 285p.

Progress is reported on fundamental research in: crystal physics, reactions at metal surfaces, spectroscopy of ionic media, structure of metals, theory of alloying, physical properties, sintering, deformation of crystalline solids, x ray diffraction, metallurgy of superconducting materials, and electron microscope studies. Long-range applied research studies were conducted for: zirconium metallurgy, materials compatibility, solid reactions, fuel element development, mechanical properties, non-destructive testing, and high-temperature materials. Reactor development support work was carried out for: gas-cooled reactor program, molten-salt reactor, high-flux isotope reactor, space-power program, thorium-utilization program, advanced-test reactor, Army Package Power Reactor, Enrico Fermi fast-breeder reactor, and water desalination program. Other program activities, for which research was conducted, included: thermonuclear project, transuranium program, and post-irradiation examination laboratory. Separate abstracts were prepared for 30 sections of the report. (B.O.G.)

For abstracts of individual items see: 3713, 3714, 3969, 4171, 4172, 4173, 4174, 4175, 4176, 4177, 4178, 4199, 4212, 4213, 4246, 4247, 4248, 4249, 4250, 4251, 4252, 4253, 4254, 4255, 4256 4305, 4329, 4764, and 4835.

4171 (ORNL-3470(p.3-5)) CRYSTAL PHYSICS. (Oak Ridge National Lab., Tenn.).

Crystals of BeO greater than 2 mm on an edge were grown from the solvent, molten V_2O_5. The crystals were purer by more than an order of magnitude and apparently more perfect than previously reported crystals grown from $Li_2O \cdot 2WO_3$. Optically clear ThO_2 crystals up to 3 mm on an edge were grown from unseeded ThO_2–$Li_2O \cdot 2WO_3$ solutions. Similarly, crystals approaching 1 cm on an edge were grown on rotating seeds. Single crystals of the incongruently melting compounds UAl_3 and UAl_4, with longest dimension of 1 mm, were grown from U–Al melts. Detailed x-ray structural analysis of hydrothermally synthesized single crystals of $Cs_2O \cdot Fe_2O_3 \cdot 4SiO_2$ permitted their assignment to the cubic space group 1A3d. (auth)

4172 (ORNL-3470(p.67-74)) SOLID REACTION STUDIES. T. S. Lundy, W. K. Biermann, J. I. Federer, D. Heitkamp, and J. F. Murdock (Oak Ridge National Lab., Tenn.).

Extensive experimental data on diffusion in body-centered cubic zirconium, titanium, and vanadium demonstrated the inapplicability of the Arrhenius-type expression in describing the behavior of diffusion coefficients over wide temperature ranges. A program was initiated to study diffusion in solids in a temperature gradient. The effect of alpha bombardment on diffusion coefficients of Pb^{212} in silver is being determined. Diffusion rates of Nb^{95} in UO_2 were determined from 1100 to 2100°C. (auth)

4173 (ORNL-3470(p.75-88)) FUEL ELEMENT DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

All phases of the Fuel Element Development Program were directed toward higher temperature operation. In a new part of the program, aimed at fabricating fuel elements by vapor-deposition techniques, pyrolytic graphite, tubing of several refractory metals, and various boron–carbon compositions including B_4C were satisfactorily deposited. Fine-grained, randomly oriented tungsten tubing was fabricated with excellent control of the surface and dimensions. A combined $(U,Th)O_2$ fuel produced by the sol-gel technique was substituted for UO_2 in the development of an all-ceramic fuel element. High-quality, dispersion-type fuel bodies were fabricated by spheroidizing the individual particles and coating them with BeO before cold pressing and sintering and are undergoing irradiation tests. It was shown that UO_4 is the volatile material lost during the reduction of UO_{2+x} in vacuum. The composition of the equilibrated (solid) oxide phase as a function of oxygen pressure

was determined. By use of pure starting materials and careful prevention of surface contamination during processing, UC compacts having high and uniform densities were obtained by low-temperature sintering. Additions of UAl_2 as a sintering aid have consistently yielded densities greater than 97% with sintering temperatures of only 1400°C and with 97% of the aluminum being removed during the processing. Brazing alloys were developed that were capable of wetting and flowing on BeO and UO_2. Adequate bonding was obtained when UO_2 was brazed to a variety of metals, but some difficulty was encountered with microcracking in the UO_2. The reproducibility achievable in forming aluminum-base dispersion fuel plates was greatly increased by incorporation of a considerable amount of cold working into the fabrication sequence. The optimum fabrication temperature for such plates was shown to be 500°C when the effects of fabrication temperature on blistering and forming were balanced. (auth)

4174 (ORNL-3470(p.157-72)) MOLTEN-SALT REACTOR. A. Taboada (Oak Ridge National Lab., Tenn.).

The vapor of CF_4 was found effectively nonreactive toward INOR-8 immersed in fuel salt at 600°C, but minor attack occurred at 700°C. The debilitating effect of fluoride-salt spillage on oxidation resistance of INOR-8 was studied. The microstructure and composition of molybdenum were unchanged when it was tested with materials used in the MSRE system. The tube-to-tube-sheet joints for the MSRE heat exchanger were successfully accomplished by welding and back brazing with a gold–nickel alloy. Nondestructive ultrasonic and radiographic tests of the tube joints were developed and used. Procedures were developed for welding INOR-8 to nickel, Inconel, and austenitic stainless steel. Room- and elevated-temperature tensile properties and creep properties were measured for these weldments. Stress relieving at 1600°F was found to significantly improve the stress rupture and high-temperature ductility of INOR-8 weld metal. Random heats of reactor-quality INOR-8 to be used in the MSRE were found to have mechanical properties better than established design values. Evidence was found in INOR-8 for a dynamic strain aging that is affected by the number of impurity atoms in solution available to interfere with dislocation motion. Grade CGB graphite bars produced for the MSRE moderator met specifications except that they had a general cracked condition and some bars had densities as low as 1.82 g/cm^3. Despite this, the graphite had good mechanical strength and adequately low permeation to salt. Rapid thermal cycling between 390 and 1300°F did not damage the graphite or cause salt-impregnated cracks to propagate. Tensile strength of CGB graphite bars was found to average 5440 psi for flaw-free specimens and range down to 1510 psi for cracked specimens. Mixtures of prereacted powders of Gd_2O_3–30 wt % Al_2O_3 were successfully cold pressed and sintered into cylinders to 95% of calculated densities, but careful control of conditions is required because of distortion apparently caused by the formation of intermediate compounds. Mixtures containing 20 wt % Al_2O_3 showed less distortion when sintered at higher temperatures and should be fabricated to specification more easily. Hot-pressed Gd_2O_3–Al_2O_3 sample control-rod elements, tested by thermal and mechanical stressing, cracked but did not crumble; and the metal container was not distorted. The examination of capsules from various MSRP irradiation experiments has led to the development of a fission-gas sampling rig, equipment for in-pile gas sampling, and the discovery of fluorine as a radiolysis product. Metallographic examination of an INOR-8 capsule exposed to fuel salt for 1500 hr at a flux of 2×10^{13} and a temperature of 1400°C showed no evidence of fluorine gas attack or accelerated corrosion. (auth)

4175 (ORNL-3470(p.196-212)) THORIUM UTILIZATION PROGRAM. (Oak Ridge National Lab., Tenn.).

Because of the high radioactivity of isotopes produced during the irradiation of thorium, it is desirable to accomplish all the processing steps of a Th–U^{233} fuel cycle in a shielded and alpha-tight facility. A lightly shielded facility was built, equipped, and tested for fabricating 1000 Zircaloy-2-clad fuel rods. Mixed ThO_2–UO_2 from the sol-gel process is remotely crushed, sized, vibratorily compacted into dense rods in Zircaloy-2 tubes, and sealed by welding. Fabrication equipment is being designed for a large, heavily shielded facility with no glove port access. Thorium–uranium oxide fuels produced by the sol-gel process and vibratorily compacted have shown superior irradiation performance. Improvement of the high-temperature strength of thorium was accomplished by alloying and dispersion hardening. Several coatings to improve the attrition resistance of thoria pellets were evaluated, and satisfactory pellets probably can be produced. (auth)

4176 (ORNL-3470(p.213-20)) ADVANCED TEST REACTOR. R. J. Beaver (Oak Ridge National Lab., Tenn.).

Composite fuel plates containing 34-wt % U_3O_8 and 0.15-wt % B_4C dispersed in aluminum were roll clad with type 6061 aluminum. With careful control, plates were rolled to the desired dimensional specifications. Fewer than 1% of the plates were rejected for nonbonds. Chemical analysis has indicated reasonable control of fuel homogeneity. A two-strike low-pressure marforming process was developed for forming mass quantities of fuel plates. By improved assembly procedures, several fuel elements were produced well within the tentative specifications. A relation was developed for predicting recovery in cold-worked aluminum as a function of cold work, temperature, and time at temperature. (auth)

4177 (ORNL-3470(p.221-6)) ARMY PACKAGE POWER REACTOR. R. J. Beaver (Oak Ridge National Lab., Tenn.).

Economical arc-melting procedures were developed to produce dense, stable materials for control and burnable poison. These include both Eu_2O_3 and the newly corrosion-resistant compound $Eu_{5.3}MoO_{11}$. The new europium–molybdenum oxide has withstood exposure for more than 850 hr in 250°C water. Dispersions of up to 40-wt % Eu_2O_3 in stainless steel have resisted exposures up to 4×10^{21} neutrons/cm^2. The corrosion resistance of these dispersions was shown to be independent of irradiation exposure and to be primarily dependent on concentration. In an SM-1 fuel element examined after 19.5 Mwyr of operation, changes in plate thickness were proportional to burnup. No matrix cracking or gross deterioration of the UO_2 was found. Cermet samples containing up to 26-wt % UO_2 sustained burnups of 2.6×10^{21} fissions/cm^3 at surface temperatures of 600°F with no loss of structural integrity. The density decreased linearly with burnup at a rate of 4.3% per 10^{21} fissions/cm^3. (auth)

4178 (ORNL-3470(p.227-31)) ENRICO FERMI FAST-BREEDER REACTOR. W. C. Thurber and R. J. Beaver (Oak Ridge National Lab., Tenn.).

Procedures capable of brazing the Fermi Core B fuel element in a single operation were developed. Seven of these stainless steel–UO_2-dispersion fuel elements were

fabricated. Miniature specimens of the Core B fuel plates were examined after being irradiated in the MTR at 700 to 1200°F for burnups to 29%. Considerable swelling and microcracking of the matrices occurred in the samples irradiated to the higher burnups. (auth)

4179 (RTD-TDR-63-4109) CERAMIC TO METAL SEALS FOR HIGH-TEMPERATURE THERMIONIC CONVERTERS. M. L. Dring (Bendix Corp. Red Bank Div., Eatontown, N. J.). Oct. 1963. Contract AF33(657)-10038. 89p.

A rather broad investigation was carried on in the materials and methods which are considered possibly useful in forming ceramic to metal seals and composite structures for use in the environment of cesium-plasma thermionic converters. Initially, studies of five specific means of joining refractory metals to alumina were undertaken, as well as studies of metallizing methods, of forming graded tungsten-alumina composites, and of the possible metals and ceramics which could be utilized best in structures operated at 2000°C. The five joining methods studied are: (1) Formation of a continuous electroplated layer of refractory metal across the adjacent surfaces of metal and ceramic. (2) Welding of a metal member to the ceramic by ultrasonic welding techniques; i.e., without heat. (3) Use of high temperature brazing alloys. (4) Formation of a bond between metal and ceramic by the diffusion of compatible intermediate materials into both structural members. (5) Welding of single oxide ceramics directly to refractory metals using electron-beam welding equipment. The study of metallizing methods was started because the first three of the joining methods listed require the use of a metallized surface of the alumina. It was determined that three of the five methods for joining refractory metals to alumina which were under study were not practically feasible. The methods considered impractical are: formation of a continuous electroplated joint, welding by ultrasonic energy, and welding with electron beam techniques. The studies on these methods were ended. Significant achievements have been made in the other studies. A metallizing process has been developed by which a strongly adherent sintered tungsten film can be applied to commercially available, high-purity, silica-free alumina. No fluxing materials or active metals which are susceptible to attack by cesium are used in this process. Bonding of alumina to molybdenum has been successful by several methods developed from the diffusion seal study. Some of these have been tested at 1500°C successfully, i.e., with neither structural failure nor loss of hermeticity resulting from the test. Methods of fabricating graded-composition, tungsten-alumina emitter and envelope structures have been developed. Techniques for making brazed joints between refractory metals and high-purity alumina metallized with tungsten, using high temperature brazing alloys, are considered to be well enough developed for use of these structures near 1500°C. Diffusion joining methods for molybdenum or niobium and alumina are also considered to be processes which are immediately applicable to joining molybdenum or niobium and commercially available high-purity alumina for use at this temperature. Tungsten, rhenium, hafnia, thoria, and yttria have been identified as the most promising materials for 2000°C service. The techniques developed for fabrication of tungsten-alumina composite bodies are considered to be directly applicable to formation of composite structures utilizing combinations of the materials for 2000°C service. Diffusion bonding of tungsten or rhenium to hafnia, thoria, or yttria demonstrates a high potential capability as a means of joining these materials for use at 2000°C. (auth)

4180 (SSD-TDR-63-51) A PORTFOLIO OF EXPERIENCE IN REFRACTORY METAL PROTECTIVE SYSTEMS RESEARCH. Donald H. Leeds (Aerospace Corp., El Segundo, Calif.). Mar. 11, 1963. Contract AF04(695)-169. 377p. (AD-400921)

This report supersedes Report TDR-169(3240-31) TR-1, (AD-295027) Re-Entry Protective Systems: A Bibliography of Refractory Metals Protective Systems Research, published 6 August 1962.

The purpose of the present document is two fold: to direct research in the field of refractory metals protective coatings away from present silicide approaches and into systems capable of protection over 3500°F, and to familiarize the materials engineer with past and current research in his field (including the valuable examples set by silicide protection theory), thereby enabling him to interpret his own science for the designer. The report is divided into five major sections: molybdenum (366 references); columbium (299 references); and a new section, general (2401 references), which contains references to oxidation testing of refractory metal systems and to areas of research allied to the one vital problem, the protection of these metals from unfavorable environments at elevated temperatures. (auth)

4181 (UCRL-7428) BERYLLIUM OXIDE FOR NUCLEAR PROPULSION APPLICATION. A. J. Rothman (California. Univ., Livermore. Lawrence Radiation Lab.). July 1, 1963. Contract W-7405-eng-48. 53p. (CONF-173-2)

From Symposium on Ceramics in Aerospace Technology, Los Angeles, Jan. 1963.

A review is presented of the aspects and characteristics of BeO which are relevant to nuclear propulsion problems. The various properties of single-crystal and polycrystalline BeO are considered, and BeO technology, fabrication, and radiation damage are also described. Unclassified characteristics of BeO–UO_2 fueled materials are considered briefly. (D.L.C.)

4182 (UCRL-10973) COMPOSITE MATERIALS FABRICATION, STRUCTURE, AND PROPERTIES. Richard M. Fulrath (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 23, 1963. Contract W-7405-eng-48. 21p.

The processing of composites plays a dominant role in determining the developed microstructure. The analysis of the properties of composite materials based on models, while successful for thermal conductivity and in some cases thermal expansion, is less successful for predicting mechanical strength. The interface between phases in a composite system is the most important parameter in the development of a composite of high strength. Interfaces which are chemically bonded or mechanically formed may improve the strength of composite materials. (auth)

4183 (WAPD-276) THE EMANATION OF RADON-220 FROM SINTERED UO_2 POWDERS AND PLATES. J. C. Clayton and S. Aronson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1963. Contract AT-11-1-GEN-14. 29p.

The emanation of thoron (Rn^{220}) from sintered UO_2 powders and plates was measured as a function of temperature. The uranium oxide samples were indexed with radiothorium by coprecipitation and coevaporation techniques. The emanation measurements were performed in a flow system, using an alpha scintillation detector and a helium-hydrogen carrier gas mixture. Both the radiothorium concentration (5 to 100 $\mu C/g$ UO_2) and the uranium oxide density (71 to 99 percent TD) were varied. The surface areas and densities of the UO_2 plates were measured

by krypton gas adsorption and liquid immersion techniques, respectively. Assuming a diffusion mechanism, diffusion coefficients for thoron in sintered UO_2 were calculated as a function of temperature. The data were represented by an equation of the form, $D = D_0 \exp(-Q/RT)$. An apparent increase in both activation energy (Q) and D_0 with density was observed for the 1100 to 1450°C temperature range. For some samples the thoron emanating power could be measured at temperatures as low as 400°C. Log D versus 1/T plots from 400 to 1450°C gave intersecting straight lines with different activation energies. One intersection occurred near the Tammann temperature. The emanation of Rn^{220} from UO_2 apparently involves several types of diffusion processes. (auth)

4184 (RSIC-71) LITHIUM, FIELDS OF KNOWN AND POSSIBLE APPLICATION. Boris Iosifovich Kogan. Translated from a publication of the Processing and Publishing House of the All-Union Institute of Scientific and Technical Information, Moscow, 1960. 153p.

The development of the lithium industry and the amount of lithium materials mined in U. S. and other foreign countries are outlined in some detail. The characteristics and prices of lithium materials are also given. Extensive lists and tables are given for the applied and possible uses of lithium and its alloys and compounds, for the properties of metallic lithium, and for the chemical and physical properties of lithium products. A bibliography of 534 references is included. (D.L.C.)

4185 ALUMINOTHERMAL REDUCTION OF LANTHANUM, CERIUM, AND PRASEODYMIUM OXIDES. V. A. Podergin and G. V. Samsonov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 5, 50-7(Sept.-Oct. 1963). (In Russian)

Aluminum alloys containing up to 30 to 50% rare earths were prepared by external alumino-thermoreduction of oxides. Maximum La content in alloys was 27.65% with 18.7% La yield into the alloy. The optimum yields of Ce and Pr were 32.0 and 28.0%, respectively. At high reaction rates (>1100 kcal/kg) the charge burned furiously. The optimum reaction for a charge of 0.105-nm aluminum powder was found at 850 kcal/kg for lanthanum and cerium oxides and 800 kcal/kg for praseodymium. (R.V.J.)

4186 Be AND BeO AS NUCLEAR REACTOR MATERIALS. Susumu Nishigaki (NGK Insulators, Ltd., Japan). Nippon Genshiryoku Gakkaishi, 5: 870-85(Oct. 1963). (In Japanese)

The practical use of beryllium and beryllium oxide as nuclear reactor materials is discussed. The nuclear reactor applications of beryllium and beryllium oxide can be classified into three divisions: beryllium as a fuel cladding material of high-temperature gas-cooled reactors; beryllium or beryllium oxide as a reflector material of testing reactors; and beryllium oxide as a moderator material of high-temperature gas-cooled reactors or as a fuel matrix material. (auth)

4187 COLUMBIUM AND TANTALUM. Frank T. Sisco and Edward Epremian, eds. Wiley Series on the Science and Technology of Materials. New York, John Wiley and Sons, Inc., 1963. 649p. $27.50.

Fourteen papers are included on the chemistry and metallurgy of niobium and tantalum. Separate abstracts were prepared for nine of the papers, five papers having previously been abstracted for NSA. (L.T.W.)

For abstracts of individual papers see: 3703, 3786, 3977, 4188, 4206, 4207, 4224, 4225, and 4283.

4188 APPLICATIONS OF COLUMBIUM AND TANTALUM. F. H. Buttner, F. E. Bacon, and R. K. Bancroft. p.560-97 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

The chief use of Nb used to be as an addition to stainless steel, but Nb is now used as a high-purity metal or in Nb-base alloys. Areas in which Nb is now used or has potential use include high-temperature work, missiles, nuclear reactors, and electronics. Nb is also used in welding rods for welding Cr-Ni steels and as an addition to a wide variety of alloys. Ta is widely used in the form of Ta_2O_5 films in capacitors, and this application is discussed in detail. Ta is also used in electronic tubes, heaters and heat exchangers, condensers, as a prosthetic material in surgery, and in high-temperature vacuum furnaces. (M.P.G.)

4189 THE TECHNOLOGY OF SCANDIUM, YTTRIUM AND THE RARE EARTH METALS. Eugene V. Kleber and Bernard Love. A Pergamon Press Book. New York, The Macmillan Co., 1963. 211p.

Information is presented on sources of supply, methods of recovery from ores, methods of separation and purification of the individual rare earths, and procedures for the preparation of metals from the purified compounds. Present and possible future uses of rare earths, in both metallic and nonmetallic forms, are also considered. However, special emphasis is placed on the physical, mechanical, and chemical properties of the rare earth metals and their alloys. (P.C.H.)

4190 POROUS MEMBRANES AND METHODS OF MANUFACTURING THESE MEMBRANES. Pierre Plurien and Jean Parisot (to Commissariat à l'Énergie Atomique). Canadian Patent 667,155. July 23, 1963. Priority date May 22, 1956, France.

A method is given for fabricating a corrosion-resistant membrane suitable for use as a diffusion barrier in gaseous isotope separation. The method comprises forming an emulsion of Teflon, treating the emulsion with a coagulant to form a moist paste, coating a corrosion-resistant metallic fabric with a layer of the paste, fixing the layer on the fabric, and eliminating the coagulant from the layer, e.g., by drying. The coagulant may be an alcohol, cyclohexanol, acetone, or acetic acid, and a nonionic wetting agent may also be added to the emulsion. The mechanical resistance of the membrane may be improved by adding a filler of e.g. Ni, CaF, or TiO_2. (D.L.C.)

4191 SURFACE HARDENING OF METAL BODY CONSISTING OF OR CONTAINING TITANIUM OR ZIRCONIUM. Zenichiro Takao, Shigeo Inomata, and Koichi Nakano (to Kobe Steel Works, Ltd.). U. S. Patent 3,111,434. Nov. 19, 1963. Filed Aug. 1, 1960.

A layer is formed on the surface of the titanium, zirconium, or alloys of titanium or zirconium by reacting the body with a gaseous element in an inert gas-shielded arc welding arrangement. The surface of the body is heated to a molten state and the reactive gas is introduced into the inert gas so that while the body is being arc welded and shielded by the inert gas the layer is being formed by the reactive gas. The surface may be titanium, zirconium, an alloy of 0.025% C, 0.065% Fe, 0.05% Si, 1.06% Mo, 4.53% Al, 2% Cr, and the remainder titanium, or an alloy of 0.2% C, 0.075% Fe, 0.015% Si, 4.36% Al, 4.5% Mn, and the remainder titanium. The inert-gas shield is argon or helium and the reactive gas is oxygen or nitrogen. Metal is deposited from a filler metal rod during arc welding. Examples of these combinations are given. (R.E.U.)

Corrosion

4192 (AERE-R-4422) THE CORROSION OF BERYLLIUM AND SOME BERYLLIUM ALLOYS BY HIGH-TEMPERATURE WATER AND STEAM. J. T. Demant, R. E. Wiggins, and P. Gibson (United Kingdom Atomic Energy Authority. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1963. 29p.

Tests of beryllium and a few beryllium alloys in water and saturated steam at 325°C, and in dry steam at 500°C, are reported. At 325°C, saturated steam is significantly more aggressive than water. There are large and irregular differences of corrosion behavior between specimens of beryllium prepared by various fabrication routes. A powder route involving tungsten arc-melting appears, however, to be the most likely to yield resistant material. Additions of nickel (0.5 to 5% by weight) confer resistance to water, and even to saturated steam, at 325°C; but calcium-containing alloys have poor resistance. Corrosion at 500°C seems less severe than that in steam at 325°C. Pre-exposure to air at 500°C significantly increases the resistance of beryllium to subsequent corrosion in wet steam, and it may also diminish corrosion at 500°C. (auth)

4193 (BNL-811) THE INVESTIGATION OF CONTAINER MATERIALS FOR Bi AND Pb ALLOYS. PART I. THERMAL CONVECTION LOOPS. A. J. Romano, C. J. Klamut, and D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). July 1963. Contract AT-30-2-GEN-16. 28p.

Materials for containing liquid Bi and Pb alloys were tested in the form of thermal convection loops operating at temperatures up to 650°C, both with and without inhibitors in the liquid metal. Zr was found to be the most effective inhibitor in retarding the corrosion of low alloy steels. Carbon steel loops were operated at a temperature differential of 150°C (550–400°) for >10,000 hr with little corrosion detected. Liquid Pb and Pb–Bi eutectic were found less corrosive than Bi and U–Bi. (auth)

4194 (CONF-329-1) UTILIZATION OF RADIOACTIVE TRACERS IN STUDYING CHLORIDE STRESS CORROSION CRACKING OF STAINLESS STEEL. R. F. Overman and R. P. Jackson (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 23, 1963. Contract AT(07-2)-1. 15p.

From Southeast Regional Conference of the National Association of Corrosion Engineers, Miami, Nov. 1963.

An investigation was conducted to study the conditions necessary to produce corrosion attack and to initiate surface cracks in stainless steel. Flat specimens with ground surfaces were used. Of the various anions producing corrosion, only ≥2 ppm chloride produced cracks. MnS inclusions in the steel were correlated with corrosion sites. The possible inhibition of corrosion and crack formation was studied; the rate of dissolution of a protective phosphate film on stainless steel in 100 ppm chloride solution was measured. (D.L.C.)

4195 (GEAP-4182) SODIUM MASS TRANSFER. V. 1962 TEST RUN REPORTS. R. W. Lockhart, comp. (General Electric Co. Atomic Products Equipment Dept., San Jose, Calif.). June 1963. Contract AT(04-3)-189. 325p.

A compilation is given of the reports on the eleven test runs which were completed in 1962 on sodium mass transfer effects in six test loops. The test loops were fabricated with various combinations of three materials (316 stainless steel, 2¼ Cr–1 Mo alloy steel, and 5 Cr–½ Mo–½ Ti alloy steel) and were operated at cold and hot leg temperatures of 305 to 450°F and 1100 to 1200°F, respectively. Corrosion tests using the same materials as the test loop section in which the samples were located also were carried out. (D.L.C.)

4196 (GEAP-4393) A CONTROLLED-ENVIRONMENT STEAM CORROSION FACILITY. W. B. Nelson (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 22p. (EURAEC-893)

A low-flow autoclave system was developed for out-of-pile corrosion testing of materials in controlled environment steam up to 500°C. The system was set up in triplicate to provide for the exposure of various zirconium alloys to steam at 300, 400, and 500°C. The oxygen and hydrogen content of the steam were controlled at 25 ppm and 3 ppm, respectively, to simulate the gas conditions from radiolytic water decomposition found in a boiling water reactor. The autoclave internals were so designed to result in a temperature variation between specimens under test of less than 2°C. (auth)

4197 (MSAR-63-161) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. Physical Properties of Materials. Report No. 1. (MSA Research Corp., Callery, Penna.). Nov. 1963. Contract AT(11-1)-765. 80p.

A research program was initiated for determining the effects of reactor-grade sodium and contaminants on Type 316 stainless steel and 2¼ Cr–1 Mo steel. Two identical loops were constructed to accomplish the program in conjunction with test facilities for obtaining creep, creep-to-rupture, and fatigue data in dynamic sodium systems at high temperatures. The design and operational procedures of the test loops and facilities are described. (D.L.C.)

4198 (NMI-1911) BERYLLIUM CORROSION. Final Technical Report to United States Atomic Energy Commission, April 25, 1962 to April 24, 1963. D. S. Kneppel (Nuclear Metals, Inc., West Concord, Mass.). Mar. 24, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3012. 95p. (EURAEC-804)

An investigation of the corrosion behavior of beryllium showed that commercial-purity beryllium will survive in 343°C water without significant attack for prolonged periods. The presence of minute amounts of copper in the water has a deleterious effect on corrosion resistance. High-purity beryllium exhibits poor corrosion resistance in high temperature water. However, the material can be improved by alloying. Heat-treated alloys containing 0.4 wt % Ni, 0.2 wt % Ni plus 0.2 wt % Fe, or 0.5 wt % Ni plus 0.5 wt % Fe showed good corrosion resistance in 343°C water. Individual alloy additions to high-purity beryllium of Al, Mg, Mn, Si, Fe, Ni, or Cr in amounts comparable to their content in commercial-purity beryllium had no effect in improving the corrosion resistance. The results suggest that a particular combination of elements may be responsible for the fact that the corrosion resistance of commercial purity material is superior to that of high-purity beryllium. (auth)

4199 (ORNL-3470(p.6-10)) REACTIONS AT METAL SURFACES. J. V. Cathcart, R. E. Pawel, and G. F. Petersen (Oak Ridge National Lab., Tenn.).

Studies of the fundamental mechanisms of oxidation were continued, and the role played by stress in oxidation mechanisms remained a topic of primary interest. The large surface stress accompanying the solution of oxygen in niobium was measured directly by the flexure of specimens oxidized on one side only. The recrystallization of anodic oxide films on niobium and tantalum was investigated to improve understanding of the mechanism of destruction of the protective qualities of thermally formed oxide films on these metals. A study of the influence of surface impurities on the state of strain in Cu_2O films and on the oxidation kinetics for copper provided additional information on the relation between strain and oxidation kinetics. (auth)

4200 (TID-18364) AN X-RAY STUDY OF OXIDIZED URANIUM SURFACES. L. Leibowitz, J. D. Bingle, and M. Homa (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 7p. (UAC-7170)

There appears to be a change in the character of the oxide formed on uranium between 400 and 500°C. At 400°C and below, the adherent oxide seems to contain an oxide higher than UO_2, possibilities being U_3O_7, U_4O_9, and $UO_{2.3}$. At 500 and 600°C, the oxide seems to be a single UO_2 phase. When oxidation continues to such an extent that flaking of the oxide occurs, U_3O_8 forms but there is no evidence for the presence of U_3O_8 in thin adherent oxide films. This change in the oxide between 400 and 500°C coincides with a change that has been found in the oxidation rate law. It seems reasonable that this change in the oxide is responsible for the change in oxidation kinetics. (auth)

4201 (TID-19756) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 38, October 1963. (MSA Research Corp., Callery, Penna.). Contract AT(11-1)-765. 31p. (MSAR-63-156)

The effects of air, helium, and sodium on the creep-rupture and fatigue properties of chromium–molybdenum steel at 1100°F are evaluated. The effects of oxygen and carbon in the sodium loop are analyzed with respect to concentration. (N.W.R.)

4202 CORROSION RESISTANCE OF TYPE 329 STAINLESS STEEL IN NITRIC ACID CONTAINING CHLORIDE ION. Irvine I. Tingley (Dept. of Mines and Technical Surveys, Ottawa). Corrosion, 19: 408t-13t(Dec. 1963).

Type 329 stainless steel, previously found to have a corrosion resistance markedly greater than that of Types 316, 304L, and 309SCb in the condensing vapors from solutions of 7.5N HNO_3 and 0.2N HCl, was found resistant in similar solutions with Cl contents up to 0.38N. Welded specimens of Type 329 must be fully annealed to prevent severe intergranular attack in the heat-affected zone when immersed in boiling solutions of the above-mentioned compositions. The mechanism of the attack and the influence of accumulated chromic and ferric ions are discussed. The behavior of severely stressed specimens of the steel in these solutions was also investigated and compared with that of Type 316 specimens. (auth)

4203 EFFECT OF OXIDATION RATE ON HYDRIDING OF ZIRCONIUM ALLOYS IN GAS MIXTURES CONTAINING HYDROGEN. D. W. Shannon (General Electric Co., Richland, Wash.). Corrosion, 19: 414t-20t(Dec. 1963).

Mechanism studies showed that the primary factor controlling the hydrogen absorption of zirconium alloys in gaseous atmospheres containing hydrogen is the rate at which oxidant (H_2O) is transferred to the metal surface from the environment. The oxidation rate of Zircaloy-2 is shown to be pressure independent from 1500 psi to below 1 mm water vapor pressure. When an oxidant is present remarkable inhibition of gas phase hydriding at 400°C occurs even up to 1000 psi hydrogen pressure. However, at sufficiently low oxidant concentrations in the presence of an inert carrier gas, the oxidation rate can be reduced, due to local depletion of the oxidant. Once the oxidation rate is diffusion limited, catastrophic hydriding can occur at low hydrogen pressure (7 mm Hg), and relatively low temperatures (150°C), in a few days' time, with pre-existing autoclave films offering only transitory protection. The electrical resistance of ZrO_2 corrosion films decreased in the order of 10^6 ohms when the atmosphere was shifted from oxidizing to nonoxidizing, probably due to an increase in the oxygen anion vacancy concentration. This suggests the initiation of gas phase hydriding may be related to a higher hydrogen diffusion rate made possible by the higher concentration of oxygen vacancies in the film. (auth)

4204 ELECTRONOGRAPHIC INVESTIGATION OF OXIDATION OF SCANDIUM COATING. O. P. Naumkin and D. V. Ignatov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 5, 141-4(Sept.-Oct. 1963). (In Russian)

Physico-chemical properties of metallic scandium were studied, and oxidation and other phases formed by heating thin (400 Å) scandium coatings in air at 20 to 900°C were determined by electronographic methods. An oxide film consisting of Sc_2O_3 with a Mn_2O_3 lattice and a 9.833 ± 0.005 kX constant formed at room temperature. The maximum oxide coating thickness formed during 25°C air exposure for 128 days was ~150 Å. Protective properties are retained to 300°C, after which the 400 Å coating oxidized within 2 hrs. (R.V.J.)

4205 CORROSION RESISTING FILMS OF TITANIUM AND ZIRCONIUM IN HIGH TEMPERATURE WATER AND SEVERAL AQUEOUS CHLORIDE SOLUTIONS. Tadayuki Nakayama (Waseda Univ., Japan), Hiroyuki Yamada, et al. Nippon Kinzoku Gakkaishi, 27: 318-23(July 1963). (In Japanese)

Corrosion-resisting films and surfaces produced on Ti and Zr were studied by the electron microscopy and diffraction. The corrosion-resisting films on Ti produced in high-temperature water (200°C, 6hr) consist of rutile and anatase. Zr plate was covered with monoclinic and cubic ZrO_2 crystals showing the preferred orientations of their {110} and {100} planes parallel to metal surfaces, but these oriented films were not found on cast specimens under the same conditions. The protective films on Ti immersed in boiling 10 and 28 wt % NaCl solutions consist of anatase and rutile, respectively. The surface films produced on Ti in artificial sea water and 10 wt % NaCl solution (200°C, 6 hr) were composed of rutile and anatase, and the surfaces were individually protected with rutile or rutile and α–Ti_2O_3 when the specimens were corroded in high-temperature 20 or 28 wt % NaCl solution. Zr plates dipped in artificial sea water, 10 ~ 28 wt % NaCl solutions (200°C, 6 hr) or boiling 10 wt % $AlCl_3$, $MgCl_2$, and NH_4Cl solutions were covered with oriented ZrO_2 films. Rutile was found on Ti dipped in boiling 10 wt % $FeCl_3$ solution, while films consisting of rutile and anatase were detected on surfaces of Ti boiled in 10 wt % $CuCl_2$ solution. Protective films on Ti in boiling 10 wt % $AlCl_3$, $MgCl_2$, and NH_4Cl solutions were composed of anatase. (auth)

4206 CORROSION AND ELECTROCHEMICAL BEHAVIOR. Milton Stern and C. R. Bishop. p.304-46 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

A list of ~100 media that have little or no corrosive effect on Ta is presented. Nb has similar corrosion-resistant properties, but is not so resistant as Ta to some of the more aggressive media. Ta and Nb are attacked by environments containing fluorides and by alkaline solutions. Results of corrosion tests on Ta and Nb in various acids and oxidizing and reducing environments are tabulated. Ta absorbs H and becomes brittle at high temperatures and, under special conditions, at room temperature. Data on the influence of fabrication, minor alloying additions, heat treatment, and contact with noble metals on H embrittlement of Ta are tabulated and discussed. Data are also presented on the effectiveness of Pt and Pd in protecting Ta from embrittlement. Pt contact to Ta appears to be quite effective, Nb is much more susceptible to H embrittlement than Ta, and Pt contact does not seem to be broadly effective in preventing it. The corrosion resistance of Ta and Nb alloys to acids and the corrosion resistance of Ta and Nb to liquid metals are summarized. The electrochemical properties of Ta and Nb, including kinetic processes, galvanic effects, and anodic behavior are also discussed. (M.P.G.)

4207 REACTION WITH THE COMMON GASES. F. E. Bacon and P. M. Moanfeldt. p.347-443 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

Nb and Ta oxidize rapidly at comparatively low temperatures. Although alloying improves the oxidation resistance, a coating is probably necessary to protect the best alloys during long exposure at high operating temperatures. The equilibrium and kinetics of the reactions of Nb and Ta with O, H, and N are discussed. Methods of testing and the effects of alloying and coating are described. The oxidation rates of binary, ternary, and complex alloys are tabulated. (M.P.G.)

Fabrication

Refer also to abstract 4784.

4208 (ANL-FGF-412) DRAWING OF TUBES FILLED WITH PARTICULATE SOLIDS. N. H. Polakowski and R. M. Mayfield (Argonne National Lab., Ill.). Dec. 31, 1962. Contract W-31-109-eng-38. 30p. (UAC-7201)

The principal parameters involved in drawing of tubes filled with metallic, mineral, and organic powders were investigated on small copper, mild steel, and 304 stainless tubing. The type of filler controlled the change of the ratio of diameter to wall thickness which increased at first but became constant after a certain reduction. The above increase could be held at a minimum by employing a center rod of ductile metal separated from the tube by a powder barrier. Such particulate core need not necessarily be an integral part of the product but can be used as a "deformable mandrel" and eventually removed from the reduced tube by melting, dissolving, or washing the powder out. This drawing procedure appears to have potential for warm reducing of refractory metal tubing because of the substantial heat capacity of the quasi-solid cross section and the elimination of relative slippage and possible local welding (galling) between tube and inside tool. (auth)

4209 (ATL-423) INVESTIGATION OF THE TECHNICAL FEASIBILITY OF COLD EXTRUSION FOR ZIRCALOY-2 TUBING PRODUCTION. Technical Progress Report. (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Sept. 1960. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 6p. (EURAEC-92)

The feasibility of cold extrusion for Zircaloy-2 tube production was studied and the basic feasibility of cold extruding Zircaloy-2 was indicated. Lubrication systems, composed of a lubricant and a conversion coating, were developed and evaluated for the current application. A fluoride-phosphate base coating and a number of promising lubricants were selected for actual extrusion tests. Bars of Zircaloy-2 were successfully cold-extruded to reductions of 50, 65, and 80%. The best lubricants provided excellent surface finish, and no evidence of cracks or other defects could be found in the specimens. Annealed extruded specimens exhibited the same tensile properties as annealed raw stock. Deformation efficiency was found to be in the same range as for cold-extruded aluminum, titanium, and steel. Cold extrusion of Zircaloy-2 heavy-walled tube shells was also found to be economic if sufficient production volume exists. (P.C.H.)

4210 (HW-79143) ELECTRON BEAM WELDING OF NUCLEAR FUEL CLADDING COMPONENTS. R. F. Klein (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 34p.

The rapid technological development of the nuclear and space industries has placed a great demand on metal joining processes. One of the most promising processes is electron beam welding. Welding with the electron beam offers high integrity in addition to the ability to fabricate unusual configurations. Advanced nuclear fuels require both reliability and unusual designs for satisfactory operation under extreme conditions of temperature and stress. To investigate the problems and techniques involved in fabricating large, advanced nuclear fuel components from Zircaloy-2 material, several cladding pieces were designed and built using the electron beam process. These designs included five basic joint types for assembling the cladding. Destructive and nondestructive examinations were employed including corrosion testing and extensive metallographic examination. Weldment size, "fit-up" of the parts to be joined, fixturing and work carriage mechanisms, as they pertain to electron beam welding, are also discussed. The electron beam process has been demonstrated as a very satisfactory method for fabricating unusual fuel cladding. Fuel cladding components with lengths up to 8 ft have been fabricated for in-reactor irradiation. (auth)

4211 (NLCO-891) BETA HEAT TREATING OF URANIUM USING A ROLLING QUENCH MACHINE. J. F. MacNeill, B. W. Schoolfield, T. D. Nixon, and D. W. Drott (National Lead Co. of Ohio, Cincinnati). Nov. 14, 1963. Contract AT(30-1)-1156. 26p.

Uranium fuel core blanks were heated in molten salt and quenched in a Gleason rolling quench machine. Both oil and water were evaluated as quenching media. The warpage of the pieces was held to very low values. Metallographic examination of the pieces showed that fine grain structures were produced with both quenching media. The structures of the oil-quenched pieces were uniform and were within reactor specifications; however, the pieces quenched in water exhibited a variation in structure in areas where mechanical pressure has been applied. (auth)

4212 (ORNL-3470(p.30-2)) BASIC SINTERING STUDIES. C. S. Morgan and C. S. Yust (Oak Ridge National Lab., Tenn.).

Evaluation of the densification kinetics of ThO_2 powder compacts during the initial sintering, as the specimens are brought to temperature, indicates that material transport occurs by plastic flow or dislocation motion. The effect of heating rate on densification was studied at much higher rates than previously, and a temperature-dependent end point has again been noted. These observations seemed to indicate that material transport caused by dislocation motion during early stages of sintering was very rapid. Impurities appear to have caused the previously reported minimum in the densification rate as a function of temperature for ThO_2 powder compacts. Thoria containing CaO sintered and underwent creep at much lower temperatures than ThO_2 without additives. (auth)

4213 (ORNL-3470(p.240-7)) TRANSURANIUM PROGRAM. D. A. Douglas (Oak Ridge National Lab., Tenn.).

Equipment for the glove-box fabrication of Pu^{242} oxide targets for the High-Flux Isotope Reactor was largely constructed and procured. In this equipment, the oxide is first pressed into pellets with an aluminum matrix and then loaded into a finned aluminum tube. The tube is sealed by automatic welding, hydrostatically collapsed on the pellets, and installed in a sleeve. Similar equipment is being designed for completely remote performance of the same operations with actinide oxides recycled from the reactor. (auth)

4214 (ORNL-3500) FABRICATION OF THE HEAT EXCHANGER TUBE BUNDLE FOR THE MOLTEN-SALT REACTOR EXPERIMENT. R. G. Donnelly and G. M. Slaughter (Oak Ridge National Lab., Tenn.). Dec. 9, 1963. Contract W-7405-eng-26. 34p.

The INOR-8 tube bundle of the primary heat exchanger of the Molten-Salt Reactor Experiment contains 163 ½-in. dia. × 0.042-in.-wall U-tubes welded to a 1½-in.-thick tube sheet, 17 in. in diameter. Procedures were successfully developed for welding and back brazing the closely spaced 326 tube-to-tube sheet joints in the unit. Trepan grooves were machined in the weld side of the tube sheet so that low-restraint edge-type welds could be made. The 82 Au-18 Ni (wt %) brazing alloy used is corrosion resistant, ductile, and produces joints exhibiting satisfactory mechanical strength. A unique joint design incorporating a trepan groove and feeder holes was used for the braze side. Nondestructive inspection of the welds revealed no defects. Good general flow of the brazing alloy was evident, and ultrasonic examination of brazed joints showed only minor scattered porosity. The completed unit passed both helium-leak and 800-psi hydrostatic tests. (auth)

4215 (TID-15247(Rev.)) WELDING STANDARDS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1963. Contract AT(45-1)-1350. 116p. (HWS-10004)

Hanford Atomic Production Operation specification guides and standards for welding and brazing are presented. Details of this manual are given in TID-4100 (Suppl.). (N.W.R.)

4216 (WAPD-TM-375) CLEANING ZIRCALOY COMPONENTS FOR PRESSURE BONDING. J. Weber, R. Lloyd, and W. L. Frankhouser (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT(11-1)-Gen-14. 39p.

The need for a laboratory program to evaluate procedures and materials for cleaning metal arose during development of pressure-bonding techniques for fabrication of PWR Core 2 plate-type fuel elements containing UO_2 wafers. The series of laboratory experiments in bonding Zircaloy to Zircaloy resulted in a combination recommendation of (1) cleaning procedures and materials, and (2) an abrasion coolant for prior surface conditioning compatible with ease of surface film removal during subsequent cleaning operations. The laboratory experiments included independent investigations of cleaning procedures and materials and of cutting fluids, and a final inter-related experiment in the shop combining cleaning variables with cutting fluids. These results led to the selection of commercially-available cleaning materials and abrasion coolants, which achieved the desired bond quality for subsequent core production operations when used with the recommended cleaning procedures. (auth)

4217 (AEC-tr-6159) INVESTIGATION ON THE SINTERING OF PURE OXIDES AND WITH ADDITIONS OF OTHER SUBSTANCES. R. Pampuch. Translated for Ames Lab., Ames, Iowa, from Prace Inst. Hutniczych, 10: 333-47 (1958). 38p.

Investigations were made on the events in the first stage of the process of sintering pure oxides, especially with respect to the temperature of the beginning of sintering. On the basis of thermodynamic considerations it is suggested that the temperature of the beginning of sintering rises with the value of the energy per unit surface. This conclusion was confirmed experimentally by investigations on the sintering of narrow granulometric fractions of a series of oxides of various structures. General reflections on the mechanism of transport of mass in the first stage of sintering suggest that the phenomena of diffusion and of evaporation-condensation play minor roles. Macroscopic flow is probable, although probably not under the influence of the superficial tension. (P.C.H.)

4218 SLIP CASTING CALCIUM FLUORIDE AND LIME-STABILIZED ZIRCONIA. C. R. Masson, S. G. Whiteway, and C. A. Collings (National Research Council, Halifax, N. S., Can.). Am. Ceram. Soc. Bull., 42: 745-7 (Dec. 7, 1963).

Techniques are described for the preparation of articles of chemically pure calcium fluoride and lime-stabilized zirconia by slip casting from ethanolic suspensions. Stable slips with good casting properties were obtained with both materials. The use of alcohol as a vehicle avoids the rapid deterioration of molds encountered with aqueous acidic slips and in this respect is convenient for the routine preparation of complex shapes in the laboratory. The effect of water on the viscosities of calcium fluoride and alumina slips is described. (auth)

4219 NUCLEAR GRAPHITE. P. Lévêque. Bull. Inform. Sci. Tech. (Paris), No. 76, 47-56(Oct. 1963). (In French)

After a review of more than ten years effort for obtaining industrial production of nuclear graphite, the general lines of future research are given. They concern especially the resistance of the graphite in the operational conditions of a power reactor. (auth)

4220 WHY USE ELECTRON BEAM WELDING? John W. Meier. Can. Machinery Metalworking, 74: No. 8, 62-4 (Aug. 1963).

Comparison was made between TIG welding and electron beam welding. The applicability of electron beam welding to various metals including heat treated and hardened steels, Mo, W, Be, Zr, graphite, and ceramics is discussed. (TCO)

4221 PRODUCTION OF URANIUM POWDER BY HYDRATION-DECOMPOSITION OF METALLIC URANIUM. PART I. DESCRIPTION OF THE INSTALLATION AND THE METHOD. R. De Anca, G. Gerboles, and J. M. Jimenez (Junta de Energia Nuclear, Madrid). Energia Nucl. (Madrid), 7: No. 27, 5-20(July-Sept. 1963). (In Spanish)

The installation for the production of uranium powder by hydration and subsequent decomposition of the hydride is described in detail. The procedure followed and the results obtained in preliminary studies on the installation design and on reaction conditions are given. The hydration, in stationary regime with free admission of hydrogen, occurs at 225 to 250°C at 0.25 kg/cm^2 pressure. Decomposition takes place at 400°C until a pressure of 10^{-2} mm Hg is reached. The size of the powder particles varies with the hydration cycles. For a simple cycle, the percentage of particles with size less than 200 μ is 50 to 65% and only 20 to 30% are less than 60 μ. For a double cycle, 80 to 90% of the particles are less than 60 μ. The emphasis in this first part is on the description of the installation and equipment, with the discussion of the experimental results and the conclusion deduced being reserved for the second part. (tr-auth)

4222 INCOMPATIBLE-METAL TUBES WELDED EXPLOSIVELY. Nucleonics, 21: No. 12, 59(Dec. 1963).

A welding technique was developed for pressure-tube reactors and joints of other metallurgically incompatible metals. A chemical explosion forces the mating surfaces to join at high speed and extremely high pressure. Small portions of the impinging surfaces are converted to molten jets that precede the closing angles along the joints. A film-free metallurgical bond is left behind. The method is most applicable where the joint is a plane surface or a constant-radius surface of revolution. Illustrated examples of 410 ss–Zircaloy-2 joints and bonding of two pieces of Be–Cu alloy are shown. (R.E.U.)

4223 LARGE CRYSTALS GROWN BY RECRYSTALLIZATION. K. T. Aust. p.452-78 of "The Art and Science of Growing Crystals." New York, John Wiley and Sons, Inc., 1963.

Discussion is given on the application of the strain anneal, grain growth, exaggerated grain growth, secondary recrystallization, phase transformation, surface energy, and lineage-induced growth methods of recrystallization to the production of Al, Cu, Fe and their alloys, Mo, Nb, Ta, Tl, Th, Ti, W, U, Zr, and ceramic crystals. 105 references are included. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4224 CONSOLIDATION. M. L. Pochon. p.72-131 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

Because of the high melting points and high degree of reactivity of Nb and Ta, conventional melting and casting processes cannot be used, and consolidation must be carried out under an inert atmosphere or in a vacuum. The sintering of powdered Ta and Nb is described in detail, including laboratory-scale studies and commercial operations. Powder-metallurgy processes and melting processes consolidate and also purify the metal by removal of trace impurities. Melting processes, including nonconsumable-electrode melting, consumable-electrode melting, and electron-beam melting, are discussed, and data on electrodes, power, furnaces, and analysis of electrode and ingot for arc-melted and electron-beam melted Nb, Ta, and their alloys are tabulated. Ingots produced by consumable-electrode and electron-beam melting require extensive fabrication. Methods that are being developed to produce shaped castings include skull melting, zone melting, and melting in a cold-crucible induction furnace. Direct and indirect reclamation of scrap from consolidation processes is described. (M.P.G.)

4225 MECHANICAL METALLURGY. M. Schussler, A. L. Mincher, J. L. Wilson, and H. E. Dufendach. p.132-68 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

The primary and secondary fabrication of Nb, Ta, and their alloys is discussed. Nb is one of the most workable of the refractory metals and can be forged, rolled, swaged, drawn, and stamped by commercial techniques. Fabrication of Nb ingots should include hot breakdown, conditioning, vacuum annealing, and then cold working by any desired technique. Only a few Nb alloys are amenable to conventional working processes. Other alloys have been processed in small quantities by specialized techniques, such as canned extrusion, impact extrusion, and explosive forming. Ta can be fabricated into a wide variety of mill products and formed parts. Little data are available on the fabrication characteristics of Ta-base alloys. Special processes and techniques for fabricating the metals and alloys are described. (M.P.G.)

4226 VAPOR DEPOSITION OF Nb_3Sn. J. J. Hanak. p.161-71 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

The reduction of gaseous chlorides of Nb and Sn on the surface of wire and ribbon at 900 to 1200°C was studied. A solenoid was fabricated and the superconducting transition temperature, critical current density, and various mechanical and physical properties were measured. (TCO)

4227 IMPROVEMENTS IN OR RELATING TO SINTERED BERYLLIUM COMPACTS. Thomas William Farthing and Cyril Albert Terry (to United Kingdom Atomic Energy Authority). British Patent 940,425. Oct. 30, 1963. Filed Mar. 4, 1960.

A process for forming sintered Be bodies is patented. The process uses powder derived from electrolytic Be, which contains less than 500 ppm of Al and Si. The aggregate Al and Si contents are adjusted to be within the range of 500 to 2000 ppm. The powder is then compacted by vacuum hot pressing to form bodies having a density greater than 90% theoretical density. Increasing the aggregate Al and Si contents substantially improves the control of the density of the compacts. (M.P.G.)

4228 IMPROVEMENTS IN OR RELATING TO ELECTROLYTIC OR CHEMICAL TREATMENT OF WORKPIECES. Louis Facquet, Jacques Daboval, and Guy Chauvin (to Commissariat a l'Energie Atomique). British Patent 943,038. Nov. 27, 1963. Priority date Mar. 22, 1960, France.

Apparatus and procedures for performing chemical or electrolytic treatments on the entire surface of a workpiece are described. Two particular uses are the electrolytic production of continuous nickel plating on uranium bars and the chemical non-electrolytic treatment of metallic and non-metallic surfaces. (D.C.W.)

4229 IMPROVEMENTS IN RADIOACTIVE SOURCES. Guy Courtois and Pierre Le Clerc (to Commissariat à l'Energie Atomique). British Patent 943,671. Dec. 4, 1963. Priority date Mar. 17, 1960, France.

An industrial source that can be used under high mechanical stresses in corrosive media and/or at high temperatures without contamination of the surrounding medium

by diffusion or leakage of the radioactive substance is described. The radioactive material is incorporated in a mass of pyroceram (free of Na and K) consisting of a crystalline glass including 2 to 20% by weight of TiO_2. The glass mass is enclosed in a stainless steel container disposed in a sintered alumina envelope. (D.C.W.)

4230 RADIATION SHIELDING SILOXANE COMPOSITIONS. (to General Electric Co.). British Patent 943,714. Dec. 4, 1963. Priority date Jan. 23, 1961, United States.

A process and compositions for producing a tungsten-filled elastomer-forming polymer that is temperature resistant and constitutes shielding against high-energy electromagnetic radiations are described. Powdered tungsten metal is added to an organo-polysiloxane convertible to the cured, solid, elastic state. The resulting polymer can be calendered, extruded, and cured. (D.C.W.)

4231 GRAPHITE COATING OF FUEL PARTICLES. (to High Temperature Materials, Inc.). British Patent 943,719. Dec. 4, 1963. Priority date May 1, 1961, United States.

A process for coating solid nuclear fuel particles with pyrolytic graphite is described. The process, carried out at 1700 to 3000°C and at pressures of 1 to 200 mm Hg, uses a vapor-phase method in which pyrolytic graphite is deposited on the solid fuel by the thermal decomposition of a hydrocarbon gas. (D.C.W.)

4232 METHODS OF MANUFACTURING POROUS BARRIERS BY SINTERING. Micheline Calis, Jean E. Charpin, and Pierre Plurien (to Commissariat à l'Énergie Atomique). Canadian Patent 657,516. Feb. 12, 1963. Priority date Apr. 26, 1957, France.

A method is given for making porous barriers for use in the isotopic separation of gases. The method comprises mixing into a paste a thixotropic binder and a powder of alumina, titania, or magnesia, whose grain size is of the same order of magnitude as that of the pores to be obtained; shaping the paste into an element of thickness less than 1 mm; and sintering the shaped paste at a low temperature so that the welding of the grains to each other is just started. For alumina, this temperature would be 1100°C as compared to a conventional sintering temperature of 1800°C. The fabrication of porous alumina tubes using this method is described. (D.L.C.)

4233 PROCESS FOR PREPARING SHAPED ARTICLES OF URANIUM SILICIDES. André Accary, Jacques Dubuisson, and Jacques Humbert (to Commissariat à l'Énergie Atomique). Canadian Patent 664,803. June 11, 1963. Priority date May 29, 1959, France.

A process is given for the production of shaped uranium silicide articles in a simple manner. The process comprises introducing into a mold an intimate mixture of U and Si particles in the desired proportions, heating the mixture in vacuo to >450°C (preferably 625 to 675°C), and then setting the product by heating in vacuo to a higher temperature (1400 to 1500°C). An apparatus using induction heating for carrying out the process is described. (D.L.C.)

4234 PLATE ASSEMBLY AND METHOD OF FABRICATION. Austin G. Silvester (to General Electric Co.). U. S. Patent 3,113,083. Dec. 3, 1963. Filed Mar. 27, 1959.

Plate assembly and a method of fabricating plates at an angle to at least one side wall are described. Plates are attached to the side walls by mechanically causing a portion of the metal of a side wall to flow mechanically onto the plate so that a cold-welding effect is achieved. (M.C.G.)

4235 PREPARATION OF HIGH-DENSITY THORIUM OXIDE SPHERES. R. A. McNees, Jr., and A. J. Taylor (to U. S. Atomic Energy Commission). U. S. Patent 3,116,106. Dec. 31, 1963.

A method of preparing high-density thorium oxide spheres for use in pellet beds in nuclear reactors is presented. Sinterable thorium oxide is first converted to free-flowing granules by means such as compression into a compact and comminution of the compact. The granules are then compressed into cubes having a density of 5.0 to 5.3 grams per cubic centimeter. The cubes are tumbled to form spheres by attrition, and the spheres are then fired at 1250 to 1350°C. The fired spheres are then polished and fired at a temperature above 1650°C to obtain high density. Spherical pellets produced by this method are highly resistant to mechanical attrition by water. (AEC)

4236 IMPROVED MAGNESIUM OXIDE SLIP CASTING METHOD. Stephen D. Stoddard and Donald E. Nuckolls (to U. S. Atomic Energy Commission). U. S. Patent 3,116,155. Dec. 31, 1963.

A process for making an aqueous magnesium oxide slip casting slurry comprising the steps of mixing finely ground fused magnesium oxide with water, milling the slurry for at least 30 hours at a temperature of 2–10°C (the low temperature during milling inhibiting the formation of hydrated magnesium oxide), discharging the slurry from the mill, adding hydrochloric acid as a deflocculent, and adding a scum inhibitor is presented. (AEC)

4237 PRODUCTION OF SLIP CAST CALCIA HOLLOWWARE. Stephen D. Stoddard, Donald E. Nuckolls, and Robert E. Cowan (to U. S. Atomic Energy Commission). U. S. Patent 3,116,350. Dec. 31, 1963.

A method for producing slip cast calcia hollow ware in which a dense calcia grain is suspended in isobutyl acetate or a mixture of tertiary amyl alcohol and o-xylene is presented. A minor amount of triethanolamine and oleic acid is added to the suspension vehicle as viscosity adjusting agents and the suspension is cast in a plaster mold, dried, and fired. (AEC)

Properties and Structure

4238 (63-RL-3252M) SUPERCONDUCTIVE MATERIALS AND SOME OF THEIR PROPERTIES. B. W. Roberts (General Electric Co. Research Lab., Schenectady, N. Y.). Mar. 1963. 129p.

The extensive activity in the application of superconductive phenomena to devices such as computers, gyros, high field magnets, various electrical devices, and recently to large particle accelerators has produced an upsurge of materials research and several hundred newly discovered superconductive materials and elements. There are more than 900 entries. The nature of superconductivity is briefly described with emphasis on material problems. Breakdowns of superconductive materials are given by: the superconductive elements, all materials found to be superconductive (or specifically not to be), alphabetically along with available crystal structure data, by increasing critical temperature, by increasing critical field, and the high field superconductive materials (or superconductors of the second kind). All entries are keyed to the literature. A list of review articles is appended. (auth)

4239 (ANL-6702) HEAT CAPACITY STUDIES OF URANIUM AND URANIUM–FISSIUM ALLOYS. Howard Savage (Argonne National Lab., Ill.) and Richard D. Seibel

(Denver. Univ. Denver Research Inst.). Sept. 1963. Contract W-31-109-eng-38. 27p.

The heat contents of high-purity uranium and uranium–fissium alloys containing 3, 5, and 8 wt. % fissium were measured at temperatures from 0°C through their fusion temperatures. The total heat content above 0°C was determined by drop calorimetry and quantitative differential thermal analysis. The total heat content from 0 to 1200°C was found to be 16.1 ± 0.3, 16.3 ± 0.6, 16.3 ± 0.6, and 16.4 ± 0.4 kcal per equivalent gram atom, for the 0, 3, 5, and 8 wt. % fissium alloys, respectively. Curves of the heat content versus temperature are plotted for all the alloys and the high-purity uranium. Heats of transition and of fusion were determined. The directly measured value of 2.9 ± 0.1 kcal/g-atom for the heat of fusion of uranium is consistent with that of the alloys. (auth)

4240 (CONF-356-1) NEUTRON RADIOGRAPHIC INSPECTION OF HEAVY METALS AND HYDROGENOUS MATERIALS. Harold Berger and I. R. Kraska (Argonne National Lab., Ill.). Mar. 11, 1963. Contract W-31-109-eng-38. 21p.

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963.

The possibility of using thermal-neutron radiography for inspecting heavy metals and hydrogenous materials was examined. The data include exposure curves, contrast sensitivities, and an assessment of the influence of higher energy neutrons and interfering gamma radiation on image quality. It is shown that, in the case of homogeneous materials, neutron radiography presents definite advantages for the inspection of heavier metals such as uranium, bismuth, and lead, and that the images obtained in such inspections are influenced very little by other radiation in the thermal-neutron beam. This is somewhat less true for intermediate metals such as steel and tungsten, although in these cases too, some exposure time advantage can usually be gained. Nevertheless, neutron radiographic inspection of these intermediate materials may be limited to those cases in which some complication, such as radioactivity of the sample, is involved. Thermal-neutron inspection of hydrogenous materials having a thickness greater than about an inch is not recommended and may be useful primarily in special cases such as one in which the light material is in some combination with a heavier, x-ray absorbing material. (auth)

4241 (DRI-2123) A STUDY OF THE SYNTHESIS AND PROPERTIES OF TRANSITION METAL HYDRYLS. Fifth Quarterly Progress Report, July 1, 1963 through September 30, 1963. Charles B. Magee (Denver. Univ. Denver Research Inst.). Oct. 18, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1185. 18p. (EURAEC-865)

A number of experiments in which hydrogen has been added to $Rh_3(LiH)_8$ to form $Rh(LiH)_4H$ at 550°C have failed to show a plateau pressure when the equilibrium pressure of hydrogen is plotted against the gram-atom fraction of hydrogen in the condensed phase, N_H. This may be interpreted to mean either that three phase equilibrium between the two hydryl compounds and hydrogen gas does not exist at this temperature or that true equilibrium was not established in the experiments. In a number of attempts to prepare pure $Rh_3(LiH)_8$ and pure $Rh(LiH)_4H$, extraneous, unidentifiable lines have appeared in the x-ray diffraction patterns of the materials produced. The source of and the explanation for these lines have not as yet been established. When hydrogen is added to the intermetallic compound, LiRh, at 704°C, the equilibrium pressure versus N_H curve shows two plateaus. These plateaus are interpreted to mean that four phases are in equilibrium over the range of N_H values which correspond to the plateau pressures. The phases present for the plateau at low N_H values (0.030 to 0.154) are thought to be hydrogen gas, rhodium, the intermetallic compound, and $Rh_3(LiH)_8$. The presence of these phases can be inferred from the tentative ternary phase diagram. The phases present for the plateau at higher values of N_H cannot as yet be specified. A tentative phase diagram has been determined for the Li–Rh binary system. The features of this diagram are two eutectics on either side of the intermetallic compound, LiRh. The compositions of the two eutectics are estimated to be 7 and 76 atomic percent rhodium. The lithium-rich eutectic melts at 180°C and the rhodium rich eutectic melts at about 1630°C. The melting point of LiRh is of the order of 1800°C. (auth)

4242 (EUR-402.i) CONTRIBUTO ALLO STUDIO DELLA DISSIPAZIONE INTERNA E DEL MODULO ELASTICO DINAMICO DEL SAP-ISML. (Investigation on Internal Friction and the Dynamic Elastic Modulus of SAP-ISML). T. Federighi and D. Gelli (Istituto Sperimentale Metalli Leggeri, Novara, Italy). 1963. 34p. (CONF-167-3)

From Journées Metallurgiques d'Automne, Paris, Oct. 1962.

Dynamic elastic modulus (resonance frequency) and internal friction measurements have been carried out on SAP-ISML with the double purpose (i) of making an attempt to clarify the mechanisms (of internal friction) in this material and (ii) of reaching more informations on the general structural properties of the material itself. Measurements have been carried out between 20 and 500°C, in the kilocycle frequency range, employing a Bordoni type apparatus. From the point of view of the general properties of SAP-ISML, the measurements effected confirm that SAP in the cold worked state is a material which inherently maintains the properties of cold worked materials despite any subsequent annealing treatment. (auth)

4243 (EURAEC-613) THE DEVELOPMENT OF A NEW DETERMINATION OF THE DUCTILE-BRITTLE TRANSITION TEMPERATURE. Quarterly Report, January–March 1963. H. C. Van Elst (Netherlands. Nijverheidsorganisatie, Two, The Hague). Apr. 23, 1963. Includes THE INTERMITTENT PROPAGATION OF BRITTLE FRACTURE IN STEEL. Apr. 3, 1963. Work Performed Under United States–Euratom Joint Research and Development Program. 101p.

Determination of Stress Waves in the Robertson Test. Framing camera observations of brittle fractures in steel plate confirm the temperature dependence of the stepwise propagation mechanism. Dynamic stress patterns were also recorded. A detonator and a bolt gun were used to initiate the fracture, with the latter proving to be best. Measurements of Stress Waves Generated with Explosive or Electrical Means. The development of electrical equipment for the generation of stress waves was continued. Development of Test Method on Small Specimens for Determination of the Ductile-Brittle Transition. The stress wave absorption in cylindrical steel specimens was determined as a function of temperature at –50 to 250°C. The transmitted stress wave showed a distinct dispersion above a certain temperature. Errors prevented the use of the dispersion to measure the transition temperature. The possible use of the temperature dependence of the dynamic yield stress to determine the ductile-brittle transition is suggested. The Intermittent Propagation of Brittle Fracture in

Steel. High-speed photographic and electronic methods were used to study brittle fracture propagation in steel. The brittle fracture was found to proceed by discrete steps ranging from 30 to 2 mm, with halting times from 20 to 1 μsec. This stepwise propagation causes an intermittent emission of stress waves of the order of 100 to 200 kg/mm^2. (D.L.C.)

4244 (HW-SA-2406) CLEAVAGE SURFACE STRUCTURE OF URANIUM DIOXIDE SINGLE CRYSTALS. J. L. Daniel and S. J. Walter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 23, 1962. Contract AT(45-1)-1350. 6p.

Two photographs were made by reflection electron microscopy of the cleavage surfaces of UO_2 crystals prepared by an arc fusion process. They show natural cleavage plane directions intersecting the fracture surfaces and a fan-shaped structure. A transmission micrograph was also made of a similar fan-shaped structure. (D.L.C.)

4245 (LAMS-2965) TOTAL OPTICAL EMISSIVITY AND ELECTRICAL RESISTIVITY OF $(U_{0.3}Zr_{0.7})C$ IN THE TEMPERATURE RANGE 1400°K TO 2800°K. L. D. Tatro and L. W. Miller (Los Alamos Scientific Lab., N. Mex.). Sept. 1, 1963. Contract W-7405-eng-36. 15p.

The results of a rough measurement of total optical emissivity and electrical resistivity of a pin of $(U_{0.3}Zr_{0.7})C$ prepared from a hot-pressed powder are presented. Since the measured properties are expected to depend on the method of sample preparation, the experimental results given here are probably true only for similarly prepared samples. In the temperature range 1400 to 2800°K the measured total optical emissivity was 0.5 ± 0.1, and the measured electrical resistivity in micro-ohm cm may be represented by the equation $\rho = 150 + 5.7 \times 10^{-2}T$, where T is the Kelvin temperature. (auth)

4246 (ORNL-3470(p.16-19)) STRUCTURE OF METALS. (Oak Ridge National Lab., Tenn.).

Additions of oxygen, nitrogen, and carbon completely suppress twinning in niobium single crystals deformed in slow compression at 77°K, but hydrogen in concentrations to 1000 ppm has no effect on frequency of twinning. The (001) component in the fiber texture of aluminum rods extruded at subzero temperature is caused primarily by fragments of original (001) grains. During low-temperature annealing, these fragments act as nuclei for recrystallization. Other recrystallized texture components occur, and there is a marked difference in temperature dependence of the nucleation rate and/or growth rate of the various components. Studies continue on inhomogeneous flow in polycrystals, the texture of irradiated copper, and the role of deformation twins in nucleating recrystallization. (auth)

4247 (ORNL-3470(p.20-6)) THEORY OF ALLOYING. (Oak Ridge National Lab., Tenn.).

Galvanomagnetic properties of eight high-purity single crystals of tungsten were measured. The magnetoresistance was quadratic in magnetic-field strength for all orientations of current and magnetic field investigated. This indicates that the Fermi surface of tungsten is closed and compensated. In agreement, Hall fields were found to be positive, large, and only moderately anisotropic. The largest transverse electric field was not the odd Hall field but was an electric field even with respect to magnetic-field reversal. Sharp peaks of this property occurred whenever the magnetic field was normal to the (112) or (113) directions. The low-temperature specific heats of Hf–Zr alloys were measured. The electronic density of states, deduced from the electronic specific heat coefficient, changed slowly and nearly linearly between zirconium and hafnium. The Debye temperatures decreased from zirconium to hafnium, but less rapidly than would be expected from atomic masses alone. This finding is in agreement with the greater cohesion and elastic properties in hafnium, arising from the same factors as cause the lanthanide contraction. The solubility of lead in β-zirconium was found to reach 14.5 at.% at 1300°C, and this composition retains the body-centered cubic structure upon quenching. The first intermediate phase in the Zr–Pb system is Zr_5Pb, which probably has the β-tungsten structure. A eutectic occurs at 23 at.% Pb near 1400°C. (auth)

4248 (ORNL-3470(p.27-9)) PHYSICAL PROPERTY STUDIES. D. L. McElroy, T. G. Kollie, and W. Fulkerson (Oak Ridge National Lab., Tenn.).

Studies have continued on accurate methods of measuring the thermal conductivity of solids over a wide temperature range and on the influence of controlled variables on this property. Thermal conductivity data were obtained on UO_2 to 1350°C in a radial-heat-flow apparatus. The linear temperature dependence of the thermal resistance suggests that the only significant heat-transport mechanism operative in UO_2 to 1350°C is phonon conduction. Operation of the thermal comparator apparatus was described analytically, and a series of systematic thermal conductivity determinations was initiated. Development proceeded on several measurement methods, including a quenching method to measure thermal diffusivity to 1500°C, a direct-heating method to measure thermal conductivity to 2000°C, a probe method to measure the thermal conductivity of powders to 1000°C in a variety of atmospheres, and a technique to measure total hemispherical emittance up to 1200°C. (auth)

4249 (ORNL-3470(p.33-9)) DEFORMATION OF CRYSTALLINE SOLIDS. (Oak Ridge National Lab., Tenn.).

An improved calorimeter for the measurement of stored energy during deformation of metals and alloys was designed and constructed. Stored energy in a series of deformed copper–zinc alloys appears to be related to effects on short-range order. With an electron microscope, dislocation density as a function of deformation was measured for a series of dilute alloys of aluminum in nickel previously studied with the calorimeter. Dislocation density for a given strain was independent of composition. However, the addition of aluminum appeared to suppress a cell structure observed in pure nickel. The effect of strain rate on the drop of the yield point in iron showed that the yield point is caused by the multiplication of dislocations and not to the unlocking of dislocations from their impurity atmospheres. Yield-point data on the copper–aluminum alloy were analyzed. The low-temperature creep properties of alpha-iron were studied. A direct determination showed the activation energy and activation volume to be independent of temperature, strain rate, and interstitial impurity content but dependent on stress. (auth)

4250 (ORNL-3470(p.45-8)) METALLURGY OF SUPERCONDUCTING MATERIALS. (Oak Ridge National Lab., Tenn.).

Since homogeneous materials must be obtained for both physical metallurgy studies and superconducting property determinations, segregation in alloys was studied. A casting technique was developed, which produces only microsegregation. This segregation was eliminated in most of the niobium–zirconium alloys by annealing at 1400°C for 4 to 24 hr. A metallographic technique was

developed for making quantitative analyses of the compositions of the alloys over regions ranging from 0.5 μ to several centimeters in diameter. Preliminary tests indicate that this technique is applicable to Ti-, Zr-, Nb-, and Ta-base alloys. Studies of the transformation kinetics and morphologies of niobium–zirconium alloys containing 25 to 40% Zr showed only the $\beta \rightarrow \beta_1 \rightarrow \beta_2$ reaction; no transformation to the equilibrium α_{Zr} + Nb structure occurred in one week at 400, 500, or 600°C. Composition had little effect on the incubation period for the transformation but did affect the time for completion of the transformation. Cold work accelerated the entire transformation. The maximum rate of transformation occurs at about 700°C for all compositions. A nondestructive technique was developed to determine the quality of long lengths of wire. The method uses a Keithley milliohmmeter to measure continuously the resistance of a $\frac{1}{4}$-in. section of the wire passing through the instrument. The cause of resistance variations of 10%, observed in some lots of commercial wire, is being investigated by superconducting property testing and destructive examination. (auth)

4251 (ORNL-3470(p.49-52)) ELECTRON MICROSCOPE STUDIES. (Oak Ridge National Lab., Tenn.).

Observations of dislocation substructure, mechanical twins, and impurities in niobium and niobium–vanadium alloys led to an explanation for the mechanical behavior of the body-centered cubic metals at low temperature. Two annealing processes were observed in single crystals of niobium deformed at room temperature. One process resembles homogeneous nucleation and migration of coincidence site boundaries. The other annealing process gives a gradual elimination of dislocations without boundary migration. The formation and reversion of ω-phase were followed in a Zr–15% Nb alloy, and many of the structural features of the early aging stages were clarified. (auth)

4252 (ORNL-3470(p.55-62)) ZIRCONIUM METALLURGY. (Oak Ridge National Lab., Tenn.).

Studies of the α-zirconium solubility boundary in the Zr–Nb alloy showed, by quantitative metallography, that a third phase might exist between the reported alpha and beta phases. Single crystals of dimensions up to 1 × 20 × 75 mm of zirconium and 1 × 6 × 30–40 mm of Zircaloy-2 were grown by traversing strip specimens past an electron beam that produces a hot zone 1-mm high and as wide as the strip. The phase shift occurring on reflection of incident light at the oxide-metal interface of anodized oxide films in situ was measured for both niobium and Zircaloy-2 over the spectral range of 3000 to 15,000 Å. The refractive indices of oxide films on niobium, produced by anodizing, were measured over the spectral range 3750 to 7000 Å by two methods with excellent agreement. The combination of techniques enables very accurate measurements of film thickness. A method developed for semiquantitatively determining the preferred orientation in polycrystalline Zircaloy-2 by microhardness measurements. (auth)

4253 (ORNL-3470(p.63-6)) MATERIALS COMPATIBILITY. (Oak Ridge National Lab., Tenn.).

Oxygen as an impurity can have a significant effect on the compatibility of alkali metals with refractory metals. Oxygen partitions itself between the two metal phases in the proper ratio to attain the same chemical potential in the two metals. Using this thermodynamic fact, a method was developed to predict the equilibrium distribution of oxygen between refractory and alkali metals. Theoretically calculated values of the distribution coefficient for several systems at 500 to 800°C were compared with experimental results. (auth)

4254 (ORNL-3470(p.89-93)) MECHANICAL PROPERTIES RESEARCH. (Oak Ridge National Lab., Tenn.).

This research is concerned with the effects of reactor coolant, multiaxial stress state, fatigue, and reactor irradiation on the mechanical properties of materials of interest to reactor technology. The mechanism by which hydrogen reduces the creep strength of nickel alloys was elucidated by the discovery that the presence of hydrogen in nickel reduces the dislocation pinning stress. Prestraining, even to the small strains introduced in roller-leveling sheet or straightening tubing, was shown to significantly reduce ductility of austenitic stainless steels. Austenitic stainless steels in CO_2 carburize readily if the chromium content is approximately 11%; at contents below about 5% or above 20%, carburization does not occur under the conditions studied. States of stress other than simple uniaxial stressing were studied for Inconel under low-cycle fatigue conditions at 820°C. The rupture time for this alloy could be related to the maximum principal stress and the effective stress computed from distortion energy theory. An extensometer capable of measuring displacements to ±0.0005 in. in a fast-neutron flux of 3×10^{13} nv was developed and was used in in-pile creep experiments on graphite. (auth)

4255 (ORNL-3470(p.98-125)) HIGH-TEMPERATURE MATERIALS. W. C. Thurber (Oak Ridge National Lab., Tenn.).

The High-Temperature Materials Program is developing knowledge for the design of advanced reactors using alkali metals as heat transfer and working fluids and either superalloys or refractory alloys as container materials. At pressures as low as 3×10^{-7} torr, the interstitial content of 0.040-in.-thick Nb–1% Zr alloy specimens will increase 300 ppm in 1000 hr at 1200°C. Wrapping of specimens in molybdenum foil reduces the contamination. The creep rate of Nb–1% Zr alloy at 1000°C was found sensitive to pressures of 10^{-5} to 10^{-7} torr. The vapor pressure of type 316 stainless steel in high vacua was determined to range from 3.4×10^{-9} torr at 760°C to 1.7×10^{-7} torr at 980°C. Oxide films on the stainless steel reduce the evaporation rate by approximately 50%. Tube blanks were fabricated from molybdenum alloys by extrusion and from niobium alloys by floturning. The mode and depth of penetration of oxygen-contaminated niobium by lithium were shown to depend on grain size and temperature. A Haynes 25 alloy natural-circulation corrosion loop containing boiling potassium was satisfactorily operated for 3000 hr at 870°C. Less than 0.1 mil was removed from the condenser and a small deposit of metal was seen in the cooler zones. Cracks were found in the Haynes 25 alloy and were attributed to thermal cycling associated with boiling, instabilities. Stabilization of boiling of potassium and rubidium was achieved by 150°C initial local superheating of liquid in the boiler. Vacuum creep tests were conducted on Mo–0.5% Ti, Nb–40% V–1% Ti, and Nb–1% Zr at 870 to 1300°C. The Nb–40% V–1% Ti alloy is disconcertingly weak, even at 870°C. The internal-friction spectrum of nitrogen-contaminated Nb–1% Zr alloys was related to zirconium-nitrogen interactions. A 2-ft-wide by 10-ft-high forced-circulation loop of Nb–1% Zr was fabricated in an argon-filled chamber using 74 manual welds. The total hemispherical emittance of Nb–1% Zr alloy was found to be sensitive to the contamination that occurs at 6 to 9×10^{-6} torr. Nondestructive techniques were applied to the

inspection of molybdenum alloy tubing, and a new phase-sensitive eddy-current technique was used to inspect tapered stainless steel tubing. (auth)

4256 (ORNL-3470(p.173-95)) HIGH-FLUX ISOTOPE REACTOR. G. M. Adamson, Jr. (Oak Ridge National Lab., Tenn.).

To achieve the required high performance a unique fuel element and control rod were developed. Each fuel plate contains a core with a fuel dispersion in one area and a burnable-poison dispersion in another, the contents of both varying nonlinearly across the width of the plate. A procedure was developed and demonstrated to fabricate such cores in a single pressing in greater than 95% yield. Fuel plates curved to the proper involute have now been reproducibly formed, principally by low-pressure marforming. Electrohydraulic reforming has successfully recovered out-of-tolerance plates. Reproducibility in forming has resulted principally from close control of the plate fabrication, particularly as to the variation in thickness, and from an increase in cold work. Assembly of fuel elements to stringent tolerances by several techniques has been demonstrated. Various combinations of the basic procedures were used: plates spaced by bends on the outer edges and welded to each other; mechanical attachment to inner support tube; and inner- and/or outer-plate edges welded to tubular side plates that were grooved to establish plate spacing. Sliding the fuel plates into longitudinal grooves in two concentric cylindrical side plates and attaching at both edges by circumferential welds was selected as the production method. Unusual nondestructive testing techniques were developed to ensure adherence to tight specifications. Entire plates are being inspected by x-ray attenuation to determine uranium distribution. Ultrasonic techniques were developed to determine routinely $\frac{1}{16}$-in. nonbond areas, and eddy-current techniques were developed to locate the core hump. The two control rods are cylinders over 5-ft long surrounding the core, each comprising a strongly absorbing 40-vol % Eu_2O_3 dispersion, an intermediate 40-vol % tantalum dispersion, and two almost nonabsorbing zones of aluminum. Both europium oxide and tantalum were found compatible with aluminum at 500°C, and large-size plates of both dispersions were fabricated by roll bonding. Some crack propagation was encountered forming the Eu_2O_3 dispersion plates. (auth)

4257 (PWA-2279) DETERMINATION OF THE EMISSIVITY OF MATERIALS. Quarterly Progress Report, July 1 through September 30, 1963. R. J. Hayes (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NASw-104. 45p.

A screening rig was constructed to enable preliminary evaluation of coating behavior at elevated temperatures and to avoid coating volatilization in the emittance rigs. Three materials have been tested to date, namely, Kennametals K-151A and K-162B and iron titanate. The Kennametals were found to be stable up to 1600°F and the iron titanate up to 2000°F. Emittance measurements were made for coatings of Kennametals K-151A, K-162B, nickel-chrome spinel, calcium titanate, and iron titanate. Values obtained for the Kennametals ranged between 0.82 and 0.89 in the 800 to 1600°F temperature range and were in good agreement with data obtained by other investigators. Emittance values obtained during the endurance testing of a nickel-chrome spinel coating were lower than anticipated, but testing a subsequent specimen coated by a modified plasma-arc spraying technique produced values of 0.90 between 800 and 1800°F. Testing of a specimen coated with calcium titanate by a modified aluminum–phosphate bonding technique indicated that the resulting coating had increased stability and a higher overall emittance than previously obtained. Evaluation of the endurance properties of plasma-arc sprayed calcium titanate coatings indicated that emittance values of 0.90 cannot be obtained if the specimen is initially exposed to 1000°F, although such values can be obtained by directly heating the specimen to 1400 or 1500°F. Continuation of an endurance test of an iron titanate-coated specimen during the last reporting period, produced emittance values between 0.82 and 0.85 whereas values of 0.86 to 0.87 were obtained previously. Post-test analysis of the radiator segments subjected to long term endurance testing in conjunction with the NASA space power systems program commenced with a residual gas analysis of the atmosphere in the chamber containing the SNAP-8 fin coated with silicon carbide and silica. An attempt to apply a silicon carbide coating by aluminum phosphate bonding using the technique developed during the last reporting period resulted in unsatisfactory bonding. Additional coatings have been applied by a new technique and these appear to be more satisfactory although testing at elevated temperatures has not yet been conducted. (auth)

4258 (SC-DR-268-63) EFFECT OF SURFACE PREPARATION ON THE MECHANICAL PROPERTIES OF BERYLLIUM. E. H. Mebs and J. E. Smith (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract [AT(29-1)-789]. 26p.

A series of experiments showed that the room-temperature tensile properties of beryllium (particularly elongation) are significantly affected by surface preparation. Strain rates of more than 10% are not recommended. The press-forged material used in these experiments proved to be highly directional. The vacuum hot-pressed material was much less affected by the direction of loading, but it did not display equal properties in three directions. Segregation must be taken into account when evaluating numerous samples taken from a large part. The press-forged material is either less sensitive to surface damage or less damage is imparted to it in the machining operation. (auth)

4259 (TID-7683(p.12-15)) THE STRUCTURE OF PLUTONIUM METAL. W. H. Zachariasen (Chicago. Univ.).

The results of crystal structure studies of plutonium metal are summarized. Structure data are given for all six phases, and the metallic radius is discussed in relation to related elements and to the electron configuration. (D.L.C.)

4260 (TID-18430) ON DISPERSION STRENGTHENING OF ZIRCONIUM. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). [1962]. Contract AT(11-1)-578. 8p.

Studies were made on the stability of various dispersants in the Zr matrix. Powders of Zr and La, Th, and Y oxides were blended followed by cold compaction and extrusion. The tensile strength and the 100 hr stress-rupture strength of dispersed materials were found to be higher than the strength of undispersed Zr. It was concluded that dispersion strengthening of Zr is feasible. (P.C.H.)

4261 (TID-19788) YIELD BEHAVIOR OF POLYCRYSTALLINE NIOBIUM. D. C. Huffaker and G. M. Sinclair (Illinois. Univ., Urbana). May 1963. Contract AT (11-1)-1046. 37p. (TAM-244)

The yield behavior of niobium was studied under conditions of different states of stress, temperatures and strain

rates, material compositions and microstructures. Using data gathered in the present investigation as well as that obtained from ten other sources, it is shown that a relationship including the above variables is given by: $\gamma_G = A \exp -[\Delta H^* - V(\tau_G - \tau_{iG})]/RT$. While details of the frequency factor A remain unclear, it appears that it may be treated as a constant over a wide range of temperatures and strain rates. The analysis shows that a simple parameter representation of yield behavior of niobium is feasible in terms of pertinent engineering variables. (auth)

4262 (UCRL-11011) EFFECT OF INTERFACIAL BONDING ON STRENGTH OF A MODEL TWO-PHASE SYSTEM (thesis). Donald O. Nason (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 16, 1963. Contract W-7405-eng-48. 28p.

Model systems consisting of tungsten spheres in a dense glassy matrix were fabricated by vacuum hot-pressing. Metal-glass interfacial adherence was achieved while development of crystalline phases in the glass was avoided. Interpretation rested on the existence of a model surface on which the introduction of flaws could be controlled. A new criterion based on the limitation of flaw size is advanced to explain the effect of second-phase inclusions on strength in brittle systems. The roles of surface treatment and internal stresses for bonded and nonbonded inclusions are outlined in the context of this hypothesis. (auth)

4263 CARBIDES, NITRIDES, AND SILICIDES OF URANIUM AS PROMISING NUCLEAR FUEL. L. Jakešovà and D. Jakeš (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). At. Energy Rev., 1: No. 3, 3-46(Sept. 1963).

New forms of nuclear fuel, carbides, mononitrides, and silicides of uranium, are opening up new ways of developing high-temperature reactors. The chemical, physical, and mechanical properties of these compounds, techniques for obtaining and compacting UC, UC_2, UN, and uranium silicides, and their basic cermets, ways in which they are used in reactors, and possible fuel-element canning materials are discussed. Resistance to radiation is evaluated on the basis of the studies carried out. (auth)

4264 MICROGRAPHIC STUDY OF THE CONTROLLED OXIDATION OF ZIRCONIUM. Marcel Perdereau and Jean Bardolle (Ecole Nationale Supérieure de Chimie, Paris and Faculté des Sciences, Reims). Compt. Rend., 257: 2477-80 (Oct. 21, 1963). (In French)

The controlled oxidation technique was used to follow the evolution of the oxidation layer of Zr at 800 to 850°C. Zone-melted and Van Arkel Zr in the form of plates were samples, and the final treatment was chemical polishing. The surface at 800°C evolves in the following manner. It is covered first with a transparent amorphous layer. After some time, "preferential growths" of the oxide, analogous to nuclei appear, in spite of the absence of defined crystalline form. For more important oxidations (Δ m/s < 0.5 mg/cm^2), the oxide increases perpendicular to the grain boundaries. This is called type II preferential growth. At 850°C the type II preferential growth is in the form of needles that intersect some crystals at angles of 60°. Type II oxidation is, in some cases, due partially to the presence of iron. However, it is shown that the preferential saturation of oxygen leads to type II oxidation. (J.S.R.)

4265 EFFECT OF THE STATE OF DIVISION ON THE POLYMORPHISM OF URANIUM. Pierre Grégoire, Pierre Azou, and Paul Bastien. Compt. Rend., 257: 2481-4(Oct. 21, 1963). (In French)

$\alpha \rightleftharpoons \beta$ and $\beta \rightleftharpoons \gamma$ transformations are produced in pulverized U at temperatures different from those observed in the massive metal. These temperatures vary with the degree of sintering and rapidly approach the phase transformation temperatures of massive U. (tr-auth)

4266 DISSOLUTION RATES, ELECTROCHEMICAL AND PASSIVATION PROPERTIES OF ALPHA Zr–O SOLID SOLUTIONS IN HF. W. J. James, W. G. Custead, and M. E. Straumanis (Univ. of Missouri, Rolla). Corrosion Sci., 3: 237-54(Oct.-Dec. 1962).

Studies were conducted on the mechanism of dissolution in hydrofluoric acid of alpha solid solution specimens of oxygen (up to 7.01% by weight) in zirconium. They show that the electrochemical and corrosion properties of the metal are significantly influenced by the presence of oxygen. The rate equations were first order with respect to the unionized HF concentration. The activation energies increased slightly with the oxygen content of the alloys (from 4.1 kcal/mole for 1.52% (by weight) oxygen to 5.2 kcal/mole for 6.97% (by weight) oxygen). Essentially the same values were found in HF–HCl acid mixtures, however, the rate constants increased by as much as 50% in the presence of 2.0 N HCl. ZrO_x specimens dissolving in hydrofluoric acid exhibited a strong positive difference effect, the K-values increasing slightly with oxygen concentration (in the metal) and more rapidly with the concentration of HCl in the acid mixture. The dissolution potentials of the alloys in hydrofluoric acid became more noble with increasing concentrations of oxygen. Additions of HCl made the potentials still more noble. These studies confirm that the rate controlling step in the dissolution process is the diffusion of unionized HF to the metal surface, where it reacts with the Zr to evolve hydrogen. ZrO_2 accumulates on the surface causing a decrease in dissolution rate, an increase in activation energy, in dissolution potential, and in the K-value of the difference effect. Dissolved oxygen in the metal does not alter the dissolution mechanism. However, the latter also exhibits in the form of ZrO_2, some shielding passivation ability. (auth)

4267 EFFECTS OF THORIUM AND ZINC ON RECRYSTALLIZATION OF MAGNESIUM. M. E. Drits, Z. A. Sviderskaya, E. S. Kadaner, and S. B. Fel'gina. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 5, 129-33(Sept.-Oct. 1963). (In Russian)

Binary alloys of Mg with Th and Zn were used for determining the effects of Th and Zn on magnesium recrystallization. It was found that Th increased the recrystallization temperature and strengthened the alloys up to 350°C while Zn did not increase the recrystallization temperature and the weakened alloys. (R.V.J.)

4268 AN X-RAY INVESTIGATION OF POLYMORPHISM IN ZrC. Deane K. Smith and Carl F. Cline (Univ. of California, Livermore). J. Am. Ceram. Soc., 46: 566(Nov. 1963). (UCRL-7432)

To verify the existence of a high-temperature polymorph in ZrC an investigation was made using x-ray diffractometry. Patterns obtained at room temperature and 2680°C were essentially identical except for shifts due to thermal expansion. A fcc structure is maintained at least up to 2680°C. It was concluded that is a phase change exists in ZrC heated above 2200°C it is not a first-order change. (P.C.H.)

4269 RECENT PROGRESS IN THE METALLURGY OF BERYLLIUM. J. Four Elec., No. 6, 195-6(June-July 1963). (In French)

A review is presented on the developments in mining, extraction and refining, sintering and forming of Be pow-

ders, foils, ingots, billets, and tubes and also on the physical and mechanical properties, crystal structure, and corrosion resistance. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4270 COLUMBIUM–TANTALUM ALLOYS FOR IMPREGNATING PURPOSES. R. Kieffer and H. Nowotny. Metall, 17: 669-77(July 1963). (In German)

The fabrication and properties of impregnated binary alloys, W–Cu, W–Ag, W–U, Nb–U, Ta–U, Ta–Cu, Ta–Ag, Nb–Cu, Nb–Ag, and the ternary systems, Ta–Ni–Cu and Nb–Ni–Cu are discussed. Data are given on density, electrical conductivity, hardness, and microstructure, and x-ray analysis of structure characteristics. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4271 ON THE MIXING CHARACTERISTICS OF Cb_3Sn WITH Ti_3Sn, Mo_3Al AND SIMILAR PHASES. H. Holleck, H. Nowotny, and F. Benesovsky. Monatsh. Chem., 94: 359-65(1963). (In German)

X-ray measurements were made of the lattice parameters of solutions of Ti_3Sn, Mo_3Al, Zr_3Sn, Hf_3Sn, and Nb_3Si in Nb_3Sn after homogenizing treatments at 1300 to 1600°C. Studies were made on the mutual solubilities. (TCO)

4272 EFFECTS OF IRON GROUP OXIDES ON STABILIZATION OF ZrO_2. Shigeharu Naka and Etsuro Kato (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 12: 318-22 (June 1963). (In Japanese)

In order to examine the iron oxide stabilizing effects, mixed specimens of ZrO_2 were heated at 1500°C for 1 hr and stabilized ZrO_2 in the heated specimens was determined by x-ray techniques. CoO gave best results among Fe_2O_3, CoO, and NiO, CoO could be substituted for one half the necessary amount of CaO needed to stabilize ZrO_2. The effect of NiO was almost negligible. Fe_2O_3 showed a tendency to affect the stabilization, and this might be attributed to the formation of FeO during the heat treatment. It is concluded that FeO or CoO could stabilize ZrO_2. (auth)

4273 HOW TO MEASURE HARDNESS OF PYROLYTIC CARBON. T. M. Kegley, Jr. and B. C. Leslie (Oak Ridge National Lab., Tenn.). Nucleonics, 21: No. 12, 62-4 (Dec. 1963).

A thin transparent pyroxylin film was placed on the specimens before the microhardness tests by diamond pyramid and Knoop indenter were made. The hardness of five batches of pyrolytic carbon coations on uranium carbide particles was determined. (R.E.U.)

4274 BETATRON RADIOGRAPHS IRRADIATED UO_2 FUELS. Hatsutaro Nagami, Hisashi Kamei, and Tadao Ohno (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Nucleonics, 21: No. 12, 66; 68-9(Dec. 1963).

A technique for examining the inner structure of irradiated ceramic fuel specimens using the properties of betatron x rays is presented. Results are given for a natural–UO_2 specimen that received a thermal dose of 8×10^{13} n/cm^2/sec for 8 weeks and which sustained center temperatures of 3000°C. (R.E.U.)

4275 SOLUBILITY OF METALLIC SODIUM IN MOLTEN ALKALI SALTS. Shiro Yoshizawa and Nobuatu Watanabe. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 10: No. 13, 201-9(Dec. 1960).

The solubility of metallic Na in NaOH–NaBr–NaI was measured and its mechanism is discussed in two aspects; one in the chemical dissolution according to the reaction $Na + NaOH \rightarrow Na_2O + {}^1/_2H_2$, or the metallic Na that electrodeposited reacts with caustic soda to become sodium oxide; and another in the physical dissolution, which is considered to be influenced by the interfacial tension between the electrolyte and the metallic Na. As the surface tension of metallic Na becomes low, the interfacial tension between electrolytic bath and metallic Na decreases, and thereby metallic Na tends to disperse. The physical solubility was found to increase with higher temperature. Chemical solubility was found to increase violently from 280°C, and the solubility could not be measured at low temperature for its slow reaction velocity. (P.C.H.)

4276 HYDROGEN SOLUBILITY IN Zr–O ALLOYS. K. P. Singh and J. Gordon Parr (Univ. of Alberta, Edmonton, Can.). Trans. Faraday Soc., 59: 2248-55(Oct. 1963).

The solubility of hydrogen in zirconium–oxygen alloys was determined as a function of temperature, composition, and equilibrium hydrogen pressure. The hydrogen rich boundaries between $\beta-(\beta+\delta)$ and $(\beta+\delta)-\delta$ decreases in hydrogen content as oxygen increases. The two-phase $(\delta+\epsilon)$ region was shown to exist in the Zr–O–H system at elevated temperatures. Extrapolation of the boundary between δ and $(\delta+\epsilon)$ phases to zero oxygen content leads to the value of 62 at. % hydrogen; and the narrow two-phase field $(\delta+\epsilon)$ contains between 61.9 and 62.9 at. % hydrogen at 700°C. The hydrogen content of the single phase δ and the two-phase $(\delta+\epsilon)$ regions increases as the oxygen content increases. (auth)

4277 SOLUBILITY OF DEUTERIUM IN THE ZIRCONIUM + DEUTERIUM SYSTEM. K. P. Singh and J. Gordon Parr (Univ. of Alberta, Edmonton, Can.). Trans. Faraday Soc., 59: 2256-9(Oct. 1963).

The solubility of deuterium was determined in the zirconium + deuterium system as a function of composition, temperature, and deuterium equilibrium pressure from the isotherms and the positions of the boundaries between the single-phase β—and the two-phase $(\beta+\delta)$ and $(\beta+\delta)-\delta$ were determined. The partial molal heat of solution of molecular deuterium in the two-phase $(\beta+\delta)$ region was calculated. (auth)

4278 SOME PROPERTIES AND APPLICATIONS OF BERYLLIUM WIRE. A. G. Gross, Jr., and R. G. O'Rourke. Wire Wire Prod., 38: 1087-8; 1090-1; 1161(Aug. 1963).

The physical properties of Be are tabulated, and a description is given of the fabrication of Be wire. Graphs are presented showing tensile properties, formability, and electrical resistivity of annealed and hard drawn Be wire. Applications of Be wire, including properties of a Be filament wound composite structure are discussed. (TCO)

4279 A STUDY ON HIGH TEMPERATURE TENSILE AND CREEP RUPTURE TESTS OF WELDED JOINTS OF HIGH STRENGTH STEELS FOR NUCLEAR REACTORS. Haruyoshi Suzuki (National Research Inst. for Metals, Tokyo). Yosetsu Gakkaishi, 32: 688-97(Aug. 1963). (In Japanese)

High temperature tensile and creep rupture properties of six low alloy, high strength steels were investigated for base metals and welded joints made with covered electrodes. The high temperature tensile and rupture strengths of welded joints were generally inferior to those of base metals. Tensile strength of both base metals and welded joints began to decrease at 300°C for quenched and tempered HT 60 and HT 70 steels, and at 350°C for normalized HT 60 steels. The rupture of tensile specimens of welded joints was generally located in base metal at lower

temperatures, and in weld metal at higher temperatures. Generally, higher creep rupture strengths were observed for steels with higher tensile strengths at high temperatures. As far as the present test steels are concerned, normalized steels seem to have better high temperature strength than quenched and tempered steels. (auth)

4280 THE MAGNETOSTRICTION OF GADOLINIUM AND HOLMIUM SINGLE CRYSTALS. John Karl Alstad. Thesis, Ames, Iowa, Iowa State Univ., 1963. 127p.

The magnetostriction of single crystals of gadolinium and holmium was measured. Maximum strains of 140×10^{-6} for gadolinium at 130°K and 3500×10^{-6} for holmium at 45°K were observed. An apparatus was designed and constructed to employ the standard strain gage techniques in the temperature range from 4.2 to 350°K. At 100°K the saturation magnetostriction constants for Gd were $\lambda_A = -96 \times 10^{-6}$, $\lambda_B = -161 \times 10^{-6}$, $\lambda_C = 136 \times 10^{-6}$, and $\lambda_D = 21 \times 10^{-6}$. The values indicate that gadolinium behaves like a normal ferromagnet, such as cobalt. An anomaly in the temperature dependence of the constants was observed at 218°K, and agrees with measurements of the anisotropy energy. The saturation magnetostriction constants of holmium could not be measured directly because of the high magnetic anisotropy. The strains in the principal crystallographic directions were observed as a function of the magnetic field applied along these directions. The shapes of the curves are explained on the basis of the spiral to ferromagnetic transition occurring in the magnetic structure. The unusually large magnetostriction reported for holmium is probably due to a combination of this magnetic transition and the high magnetic anisotropy. The dependence of principal strains on the direction of the maximum applied field (26 k0e.) was also measured in holmium. The unusual shapes of these curves are explained from considerations of the demagnetizing field and of the crystal symmetry. Using this model, three saturation constants were obtained for holmium; the magnitude of the constants at 4.2°K was about 2000×10^{-6}. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4281 ELECTRICAL RESISTIVITIES AND MAGNETIC SUSCEPTIBILITIES OF SOME RARE EARTH METAL–METAL HALIDE SYSTEMS. Robert Alan Sallach. Thesis, Ames, Iowa, Iowa State Univ., 1963. 98p.

In order to verify the electronic structure of rare earth metal–metal halide systems, the magnetic susceptibilities and electrical resistivities of certain compounds were measured. The susceptibilities of $NdI_{1.95}$ and $NdCl_{2.04}$ do not obey the Curie-Weiss law although there is an asymptotic approach to this behavior at low temperatures (<200°K). The data are consistent with the $4f^4$ configuration for the Nd^{2+} cation and indicate a low-lying excited state. The energy separation between the ground and excited states is equivalent to 1400°K. The calculated magnetic moments of the ground and excited states are 2.87 and 5.36 Bohr magnetons, respectively. Data for $NdCl_3$ and NdI_3 are also presented (μ = 3.78 and 3.72 B.M., respectively). The resistivity of LaI_2 is 60 μ-ohm-cm at 25°C and decreases to about 10 μ-ohm-cm at 78°K. The compound has a small, essentially temperature independent paramagnetism with a magnitude typical of the Pauli paramagnetism of metals. The results confirm the presence of a metallic conduction band in LaI_2 and preclude the existence of the discrete La^{2+} cation in this compound. However, there is magnetic evidence that such an ion may be present in $LaI_{2.4}$. Some resistivity results for CeI_2 and PrI_2 are also discussed. The specific conductivities of the PrI_3 + Pr and NdI_3 + Nd melts were determined over the complete solubility range. The results for the Nd system are typical of ionic mixtures although there are significant positive deviations from additivity. Some electronic conduction is evident in the Pr melts, the conductivity rising to 19 $(ohm\text{-}cm)^{-1}$ at 26.8 mole % Pr. The implications of the temperature coefficient of conductivity on the conduction mechanism are discussed. The contrasting properties of the compounds and melts were interpreted as resulting from a competition D and F states (defined by whether the extra electron is placed in a 5d or 4f orbital) with the F state becoming more stable as the series La to Eu is traversed. (TCO)

4282 CALORIMETRIC MEASUREMENTS ON ZIRCONIUM ALLOYS. Padmakar R. Khangaonkar. Thesis, Troy, N. Y., Rensselaer Polytechnic Inst., 1962. 56p.

An adiabatic di-phenyl ether calorimeter was constructed and calibrated for the purpose of drop experiments and for the estimation of the heats of solution of metals and alloys. A preliminary study was conducted on the heats of formation (at 300°K) of zirconium–lutecium, zirconium–terbium, and zirconium–titanium alloys, and the heats of formation of zirconium–lutecium alloys (at 1172°K). Using mixtures of hydrochloric and hydrofluoric acids for the dissolution of the parent metals and the alloys, the heats of solution at 300°K were measured. The data were used to estimate the heats of formation of the alloys ($-\Delta H_{300}$). In the range of composition studied (0–6 wt %), zirconium–lutecium and zirconium–terbium alloys show increase in ($-\Delta H_{300}$) the negative heat of mixing with increase in the percentage of the alloying element, whereas zirconium–titanium alloys show the reverse effect. Using the drop method, the heat contents of zirconium–lutecium alloys and lutecium metal were measured at 1172°K(1650°F). The data were used for the estimation of the heats of formation of the alloys in the two allotropic structures at 1172°K. The factors affecting a reliable estimation of Q_β are discussed. (TCO)

4283 ALLOYING BEHAVIOR. W. F. Sheely. p.444-506 of "Columbium and Tantalum." New York, John Wiley & Sons, Inc., 1963.

The available knowledge on the alloying behavior of Nb and Ta is summarized. The presentation is limited to binary alloy systems. The alloy phase relations are reviewed in alphabetical order of the full name of the alloying element. Phase diagrams are included where they have been published. The general features of the alloying behavior of Nb and Ta are reviewed, compared with each other, and correlated with known patterns of alloying behavior of the transition elements. (auth)

4284 PROCESSING AND SUPERCONDUCTING PROPERTIES OF Nb_3Sn WIRES. Carl L. Kolbe and Carl H. Rosner. p.17-33 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

Low temperature (4.2°K) testing of a heat treated and drawn Cu-coated wire was made with a Sn and Nb powder core to determine the effect of magnetic field, phase composition, heat treatment temperature, particle size, and inhomogeneity on its current carrying capacity. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4285 HIGH-FIELD CAPABILITIES OF HIGH-ZIRCONIUM Nb–Zr SUPERCONDUCTING ALLOYS. K. M. Ralls, A. L. Donlevy, R. M. Rose, and J. Wulff. p.35-48 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

Discussion is given on the melting and fabrication of 5

to 94% Zr–Nb wire and testing at liquid He temperature to determine the structure sensitivity of the critical current density. Other influencing factors considered are deformation, magnetic field strength, composition, heat treatment and cold work. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4286 MICROSTRUCTURE AND TRAINING OF Nb–25%Zr HIGH FIELD SUPERCONDUCTORS. M. S. Walker, R. Stickler, and F. E. Werner. P. 49-70 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

Transmission electron microscopy, electron diffraction and x-ray diffraction investigations were made of rolled and heat treated Nb–25%Zr strip to correlate recrystallization, precipitation, phases, grain boundaries, and subgrain boundaries with the results of critical current density measurements at 4.2°K. Consideration was also given to other factors including heat treatment, magnetic field orientation, and training. (TCO)

4287 SUPERCONDUCTING BEHAVIOR OF SOME BETA-TUNGSTEN STRUCTURE NIOBIUM COMPOUNDS AND THEIR ALLOYS. T. B. Reed, H. C. Gatos, W. J. LaFleur, and J. T. Roddy. p.71-87 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

The preparation of binary and ternary compounds of Nb with Sn, Ge, In, Sb, Al, Ga, and other elements is discussed. Consideration is given to the effect of interatomic distance, order-disorder, temperature, atomic density, and composition on the superconducting transition temperatures of the compounds. (TCO)

4288 SUPERCONDUCTIVITY IN SINGLE AND POLYCRYSTALLINE NIOBIUM. C. S. Tedmon, Jr., R. M. Rose, and J. Wulff. p.89-103 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

Single and polycrystals of Nb were tested to determine the effect of crystal orientation, magnetic field orientation, cold work, and microstructural defects on critical current density and superconductivity. The experimental data are considered in terms of filamentary models for superconductivity. (TCO)

4289 PREPARATION OF PROPERTIES OF CORED WIRE CONTAINING Nb_3Sn AND V_3Ga. E. Buehler, J. H. Wernick, K. M. Olsen, F. S. L. Hsu, and J. E. Kunzler. p.105-19 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

Studies were made on the effects of processing variables during the production of Nb_3Sn and V_3Ga cored wires on critical current density and superconductivity. Variables studied include firing, sintering and heat treating time and temperature, bending, final diameter, cladding material, and composition. 20 ref. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4290 CURRENT AND FIELD DEPENDENCE OF SUPERCONDUCTIVITY ON MICROSTRUCTURE IN THE NIOBIUM–TIN SYSTEM. R. Enstrom, T. Courtney, G. Pearsall, and J. Wulff. p.121-50 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

The dependence of superconductivity and critical current density on microstructure, including phase composition and distribution, lattice parameters, and order-disorder, on processing variables, including sintering and heat treating time and temperature, on magnetic field and on brittleness and tensile stress was studied. A correlation was found between superconductivity and transverse rupture strength. (TCO)

4291 THE REACTION OF STANNANE WITH NIOBIUM WIRES, AND THEIR RESULTING SUPERCONDUCTING BEHAVIOR. M. D. Banus, H. C. Gatos, M. C. Lavine, and T. B. Reed. p.151-60 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

The development of a process for depositing a coating of Nb_3Sn on Nb wire is described. Consideration is given to factors influencing current carrying capacity, superconducting transition temperature, and critical current density, including composition, coating thickness, magnetic field strendth, and order-disorder. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4292 STATUS REPORT OF THE INVESTIGATION OF THERMOCOUPLE MATERIALS FOR USE AT TEMPERATURES ABOVE 4500°F. William C. Kuhlman (General Electric Co., Cincinnati). New York, Society of Automotive Engineers, Inc., 1963, Preprint 750D, 23p. (CONF-191-7)

From Society of Automotive Engineers National Aeronautic and Space Engineering and Manufacturing Meeting, Sept. 1963.

The thermoelectric outputs of Re–W, Re–Ru, Re–Rh, Re–Pt, Re–Ir, Re–Mo, Re–Os, Mo–W, Mo–Re, and Ir–Re alloys versus commercial W–Re wire are shown. Re–W and Re–Ru appear to be potentially the best of these materials. The performance of BeO, ThO_2, and HfO_2 as thermocouple insulators is shown. BeO performs well to 4400°F, but ThO_2 and HfO_2 should be used with care above 4100 and 3900°F, respectively. Ir–Os and Ir–Re show promise for use as thermocouple sheath materials for temperatures to 4500°F in low pressure air for a limited time. (auth)

4293 STATUS AND INTERRELATION OF FAST BREEDER PROGRAMS. J. H. Wright (Westinghouse Electric Corp., Pittsburgh). 41p. (CONF-334-3)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

A summary of fast breeder programs being conducted in each of the major nuclear development countries of the world is presented. These programs are compared with regard to content, adequacy, objectives, and schedule. (R.E.U.)

4294 EFFECT OF RATE OF TEMPERATURE RISE DURING GRAPHITIZATION ON THE FINAL PROPERTIES OF GRAPHITE BODIES. J. F. Hogan, J. F. Rakszawski, and M. B. Redmount (Speer Carbon Co., Niagara Falls, N. Y.). 13p. (CONF-73-19)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The effects on graphite properties of the range of graphitizing rates encountered in industrial Acheson-type furnaces were studied. It was found that at graphitizing rates over 750°C per hour, body volume expansion and density loss occurs, flexural strength and coefficient of thermal expansion levels decrease, and a simultaneous increase in electrical resistivity occurs. It is concluded that the properties affected are those of polycrystalline rather than individual crystallites. (R.E.U.)

4295 IMPROVEMENTS IN MOLYBDENUM ALLOYS. (to General Electric Co.). British Patent 943,613. Dec. 4, 1963. Priority date May 24, 1961, United States.

Molybdenum alloys containing 0.25 to 5% Ti, 0.1 to 0.5% Hf, and 0.1 to 0.2% C can be significantly hardened by plastic deformation and have a recrystallization temperature of more than 1315°C. The alloys also retain a significant degree of work-hardening up to at least 1600°C. The properties of some specific compositions are given. (D.C.W.)

Radiation Effects

4296 (AD-423158) RADIATION EFFECTS ON MICROWAVE DEVICES. Report No. 8. Final Report, July 1, 1961–June 30, 1963. E. P. Plankis (General Electric Co. Power Tube Dept., Schenectady, N. Y.). Contract DA 36-039 SC-87253. 184p.

Task 1-Voltage-Tunable Magnetrons. The results of the literature search on copper, titanium, forsterite ceramics, magnetic materials, thoriated tungsten, insulators, cables, connectors, and electron vacuum tubes are discussed. Descriptions of the monitoring techniques and experimental procedures used for voltage-tunable magnetron parameters during a pulse of nuclear radiation are included. The effects of pulsed nuclear radiation on parameters of the Z-5312 VTM package operating in air and in nitrogen are compared. Radiation effects on the Z-5337 bowl-magnet VTM package and the Z-5428 VTM package are also discussed. A comparison of the construction for the three types of VTM packages in relation to their behavior in a pulsed radiation environment is included. Dosimetry used in recording peak gamma dose rates of 2×10^7 rads/second and peak neutron fluxes of 1×10^{17} neutrons/cm^2/second is described. Task 2-Traveling-Wave Tubes. The results of the literature survey on materials used in traveling-wave tubes are given. A test procedure for monitoring traveling-wave tube d-c and r-f parameters during pulsed nuclear radiation is described. (auth)

4297 (ANL-6670) POSTIRRADIATION EXAMINATION OF EBR-I CORE IV PROTOTYPE FUEL RODS. Final Report. R. Carlander, J. H. Kittel, and R. J. Dunworth (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 11p.

Four EBR-I Mark-IV prototype fuel rods containing slugs of plutonium-1 wt % aluminum alloy were irradiated in the EBR-I reactor at central fuel temperatures from 342 to 386°C and at burnups up to 0.1 at. %. No appreciable slumping of the fuel occurred during irradiation, and no significant density nor dimensional changes were observed. Variation of the initial fuel-cladding annulus from 0.004 to 0.019 in. had no significant effect on the slumping behavior, but the larger clearance did allow the fuel pin to bow to a greater extent than that observed in fuel rods with smaller annuli. A niobium restrainer effectively decreased the amount of bowing from that found in a rod with a similar annulus, but did not appear to offer any greater restriction than that provided by a small 0.004-in. annulus. (auth)

4298 (BNL-6835) INTERSTITIAL-SINK ANNIHILATION AND INTERSTITIAL-VACANCY ANNIHILATION IN NEUTRON IRRADIATED GRAPHITE. Donald G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 19p.

Various correlations of fractional macroscopic and lattice changes in neutron irradiated graphites are used to distinguish interstitial-sink reactions from interstitial-vacancy reactions. The irradiation temperature dependence of the macroscopic expansion in the "a" direction is shown to be the same as the irradiation temperature dependence of the lattice expansion in the "c" direction and appears to reflect properties of interstitials. "a" spacing changes at different irradiation temperatures indicate that the rate of change of the lattice parameter in the "a" direction may be independent of irradiation temperature for low doses. The effect is consistent with the previously described model in which interstitials and vacancies are generated at a temperature-independent rate and supports the assumption that interstitials anneal to sinks during irradiation in lightly damaged graphite. Additional correlations of macroscopic and lattice changes with accumulated exposure can also be explained if interstitial-sink reactions predominate during the early stages of irradiation and interstitial-vacancy reactions become significant in heavily damaged graphites. Novel reverse c-axis annealing experiments are interpreted as independent evidence for the existence of interstitial-sink pairs that can be thermally decomposed at temperatures above their formation temperatures. (auth)

4299 (CONF-315-1) INFLUENCE OF THERMAL RATING AND BULK DENSITY ON IRRADIATION PERFORMANCE OF FUSED UO_2 TUBES. G. R. Cole (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Oct. 21, 1963]. Contract AT(07-2)-1. 28p.

From Norton Company's Symposium on the Technology of Powder Filled UO_2 Fuel Elements, Worchester, Mass., Nov. 1963.

Mechanically compacted tubes of fused UO_2 with bulk densities between 82 and 90% of theoretical were irradiated in the Heavy Water Components Test Reactor to 3500 Mwd/T_u at thermal ratings up to 50 watts/cm. Fission gas release up to 60% and extensive columnar grain growth occurred in elements operating at thermal ratings of approximately 40 to 50 watts/cm. Gas release was not significantly affected by bulk density but the tubes of lower density, 82 to 87%, that operated at the higher thermal ratings experienced substantial decreases in core volume and formed a lengthwise ridge in the outer sheath. (auth)

4300 (GA-4643) PART I. IRRADIATION EFFECTS ON BERYLLIUM OXIDE MATERIALS. PART II. IRRADIATION EFFECTS ON DISPERSION TYPE BeO–UO_2 FUELS FOR EBOR. M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 7, 1963. Contract AT(04-3)-187. 68p. (CONF-281-4)

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

I. The results of irradiation experiments on beryllium oxide materials are presented. The variables studied include the effects of density, grain size, composition, shape, and temperature of irradiation of the specimens. The peak exposure in the irradiation capsule was 1.0×10^{21} nvt (>1 Mev) fast neutron flux. The temperature of the specimens ranged from about 260 to 940°C. The most striking result was the excellent resistance to cracking exhibited by the high density, fine grain size specimens. The highest strength and strength retention after irradiation was exhibited by the high density, small grain size, 1% MgO-containing specimens irradiated in the high neutron flux-high temperature section of the capsule. Thermal expansion measurements provided a unique means of establishing the annealing behavior of the defects that were produced by irradiation. In beryllium oxide, a contraction set in at 850°C. Preliminary results of thermal diffusivity determinations are given. II. Fuel pellets composed of 70 vol %

BeO-30 vol % UO_2 were irradiated. The experiment was designed to study the effect of UO_2-fuel particle size on the performance of the fuel pellets at temperatures, heat-flux conditions, and burnups that are of interest in the EBOR program. The capsule accumulated 11,700 hours of irradiation in the MTR, corresponding to a peak burnup of about 55% of the U^{235} (approximately 3.7×10^{20} fissions per cc, 43,000 Mwd/ton) at a peak fuel temperature of about 2000°F. The coarse particle pellets showed little change in dimensions and remained intact. The fine particle pellets fractured into several pieces. The release of fission gases from the fine particle pellets was less than 0.1%. No fission gas release data were obtained for the coarse particle pellets. (auth)

4301 (GEAP-4325) THE MEASUREMENT OF FISSION GAS PRESSURE IN OPERATING FUEL ELEMENTS; POST-IRRADIATION EXAMINATION. M. B. Reynolds (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 20, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 37p. (EURAEC-870)

Two UO_2-filled stainless steel clad fuel rods in which fission gas pressure was measured during irradiation were subjected to post-irradiation examination. Results of free gas analysis and metallographic examination are in general agreement with observed pressures reported previously. Calculated fuel surface temperatures based on extent of fuel recrystallization indicate that in a one-half inch diameter fuel rod with 0.014 inch diametral clearance operated at a maximum heat flux of 531,000 Btu/hr-ft^2, gap conductance increased with increasing heat flux. An analysis of void configuration indicates that pressure is more sensitive to as-fabricated void volume and changes in this volume resulting from fuel expansion than to fuel central temperature. The decrease in effective void volume with increasing fuel temperature becomes more significant as initial void volume decreases, and excessive fission gas pressures may be developed in fuel rods operated at high fuel temperatures unless adequate expansion volume is provided in fabrication. (auth)

4302 (HW-SA-2274(Rev.)) EFFECT OF TEMPERATURE ON RADIATION-INDUCED CONTRACTION OF REACTOR GRAPHITE. J. M. Davidson and J. W. Helm (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 13, 1961. Contract AT(45-1)-1350. 11p.

Radiation-induced contraction as a function of temperature was studied in needle-like and conventional coke graphites from 450 to 1200°C. Fast neutron exposures ranged up to 3.2×10^{21} nvt, E > 0.18 Mev, corresponding to approximately 20,000 Mwd/at. in a Hanford graphite-moderated reactor. The results significantly extend information on the effect of high temperature irradiation on needle-like coke graphites manufactured with particle size, impregnation, and graphitization temperature as variables. In general, the transverse contraction rate goes through a broad minimum between the temperatures of 650 and 950°C with the least contraction occurring at approximately 800°C. Needle coke and CSF graphites show the same effect but the contraction of needle coke graphites is approximately 0.6 that of CSF at all temperatures. In the parallel direction, the rates of contraction are the same for both CSF and needle-coke graphites. (auth)

4303 (NP-13321) STUDY OF THE EDGE EMISSION OF CADMIUM SULPHIDE BOMBARDED BY ELECTRONS. Final Technical Report, October 1962–September 30, 1963. (Laboratoire d'Infra-rouge Technique et Appliqué, Gif-Sur-Yvette, France). Contract 62558-3576. 21p.

The luminescence of electron-bombarded CdS and Si is studied at 4900 to 5100 Å, at temperatures of 4 to 77°K. The luminescence spectra are studied with respect to the band structures. (T.F.H.)

4304 (NP-13342) SILICON FIELD EFFECT TRANSISTOR IRRADIATION TEST—2N2386, 2N2497, 2N2498, 2N2499, 2N2500. Lyndon Taylor (Texas Instruments, Inc., Dallas). Mar. 1962. 14p.

The effects of neutrons on silicon field effect transistors are reported. The transconductance of these units probably decreased no more than 50% at 1.5×10^{15} neutrons (E 100 kev)/cm^2. Pinch-off voltage and leakage currents are also reported. (N.W.R.)

4305 (ORNL-3470(p.248-51)) POSTIRRADIATION EXAMINATION LABORATORY. A. R. Olsen (Oak Ridge National Lab., Tenn.).

Construction of the new High Radiation Level Examination Laboratory was completed, and installation of equipment is in progress. For use in the HRLEL, the replication technique was improved and expanded, the ultrasonic cleaning method was modified to permit decontamination of large objects, an improved fission-gas sampler was developed, a pinhole camera for autoradiographs was built, a versatile gamma-ray spectrometer was tested, and two shielded metallographs were installed. Although not yet installed, the HRLEL x-ray diffractometer was used on many samples not requiring shielded loading. The Post-irradiation Examination Group was disbanded, and its functions were transferred to the Operations Division. (auth)

4306 (TID-19501) YTTRIUM HYDRIDE MODERATOR EVALUATION—IN-PILE THERMAL STABILITY. J. C. Marshall, R. Van Houten, W. G. Baxter (General Electric Co. Flight Propulsion Lab., Dept., Cincinnati). Nov. 20, 1962. Contract [AT(40-1)-2847]. 29p. (CONF-11-13; TM-62-11-15)

From American Nuclear Society of 1962 Winter Meeting, Washington, D. C., Nov. 1962.

The stability of a hydrided yttrium–5 weight percent chromium alloy (N_H 5.3 to 5.5) is studied in a nuclear reactor environment at 1000°C for periods greater than 1000 hours (~10^{20} nvt fast). A clad of Fe–20Cr–4.5Al (weight percent) is selected. A method is developed for nondestructively measuring hydrogen content by a neutron-scatter technique. This method allows repetitive monitoring and quantitative measurement of hydrogen loss rates in the same test specimen. Non-nuclear thermal stability is established by a series of bench tests at 980, 1040, and 1100°C in static air, dynamic air (114 ft/sec), and high-pressure air (95 psia). These tests confirm that the specimens are stable for extended periods of time at 1000°C in a non-nuclear environment. Two in-pile tests, each containing four specimens, are performed. The first experiment is run for 1950 hours at 700°C in air for an estimated thermal neutron dose of 4.9×10^{19} nvt. All irradiated specimens remain intact. There are no weight or dimensional changes; nondestructive testing shows that the core, clad, and clad bonds are sound. A chemical analysis on one of these irradiated samples indicates 2.04 weight percent hydrogen. This compares with the 2.00 to 2.08 weight percent hydrogen in the as-hydrided control specimens. The second in-pile experiment uses internal heaters in the cartridge and operates at 1000°C for 2450 hours in air for a total thermal flux of 6.2×10^{19} nvt. A preliminary

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From Norton Company's Symposium on the Technology of Powder Filled UO_2 Fuel Elements, Worchester, Mass., Nov. 1963.

Mechanically compacted tubes of fused UO_2 with bulk densities between 82 and 90% of theoretical were irradiated in the Heavy Water Components Test Reactor to 3500 Mwd/T_u at thermal ratings up to 50 watts/cm. Fission gas release up to 60% and extensive columnar grain growth occurred in elements operating at thermal ratings of approximately 40 to 50 watts/cm. Gas release was not significantly affected by bulk density but the tubes of lower density, 82 to 87%, that operated at the higher thermal ratings experienced substantial decreases in core volume and formed a lengthwise ridge in the outer sheath. (auth)

4300 (GA-4643) PART I. IRRADIATION EFFECTS ON BERYLLIUM OXIDE MATERIALS. PART II. IRRADIATION EFFECTS ON DISPERSION TYPE BeO–UO_2 FUELS FOR EBOR. M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 7, 1963. Contract AT(04-3)-187. 68p. (CONF-281-4)

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

I. The results of irradiation experiments on beryllium oxide materials are presented. The variables studied include the effects of density, grain size, composition, shape, and temperature of irradiation of the specimens. The peak exposure in the irradiation capsule was 1.0×10^{21} nvt (>1 Mev) fast neutron flux. The temperature of the specimens ranged from about 260 to 940°C. The most striking result was the excellent resistance to cracking exhibited by the high density, fine grain size specimens. The highest strength and strength retention after irradiation was exhibited by the high density, small grain size, 1% MgO-containing specimens irradiated in the high neutron flux-high temperature section of the capsule. Thermal expansion measurements provided a unique means of establishing the annealing behavior of the defects that were produced by irradiation. In beryllium oxide, a contraction set in at 850°C. Preliminary results of thermal diffusivity determinations are given. II. Fuel pellets composed of 70 vol %

BeO-30 vol % UO_2 were irradiated. The experiment was designed to study the effect of UO_2-fuel particle size on the performance of the fuel pellets at temperatures, heat-flux conditions, and burnups that are of interest in the EBOR program. The capsule accumulated 11,700 hours of irradiation in the MTR, corresponding to a peak burnup of about 55% of the U^{235} (approximately 3.7×10^{20} fissions per cc, 43,000 Mwd/ton) at a peak fuel temperature of about 2000°F. The coarse particle pellets showed little change in dimensions and remained intact. The fine particle pellets fractured into several pieces. The release of fission gases from the fine particle pellets was less than 0.1%. No fission gas release data were obtained for the coarse particle pellets. (auth)

4301 (GEAP-4325) THE MEASUREMENT OF FISSION GAS PRESSURE IN OPERATING FUEL ELEMENTS; POST-IRRADIATION EXAMINATION. M. B. Reynolds (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 20, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 37p. (EURAEC-870)

Two UO_2-filled stainless steel clad fuel rods in which fission gas pressure was measured during irradiation were subjected to post-irradiation examination. Results of free gas analysis and metallographic examination are in general agreement with observed pressures reported previously. Calculated fuel surface temperatures based on extent of fuel recrystallization indicate that in a one-half inch diameter fuel rod with 0.014 inch diametral clearance operated at a maximum heat flux of 531,000 Btu/hr-ft^2, gap conductance increased with increasing heat flux. An analysis of void configuration indicates that pressure is more sensitive to as-fabricated void volume and changes in this volume resulting from fuel expansion than to fuel central temperature. The decrease in effective void volume with increasing fuel temperature becomes more significant as initial void volume decreases, and excessive fission gas pressures may be developed in fuel rods operated at high fuel temperatures unless adequate expansion volume is provided in fabrication. (auth)

4302 (HW-SA-2274(Rev.)) EFFECT OF TEMPERATURE ON RADIATION-INDUCED CONTRACTION OF REACTOR GRAPHITE. J. M. Davidson and J. W. Helm (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 13, 1961. Contract AT(45-1)-1350. 11p.

Radiation-induced contraction as a function of temperature was studied in needle-like and conventional coke graphites from 450 to 1200°C. Fast neutron exposures ranged up to 3.2×10^{21} nvt, E > 0.18 Mev, corresponding to approximately 20,000 Mwd/at. in a Hanford graphite-moderated reactor. The results significantly extend information on the effect of high temperature irradiation on needle-like coke graphites manufactured with particle size, impregnation, and graphitization temperature as variables. In general, the transverse contraction rate goes through a broad minimum between the temperatures of 650 and 950°C with the least contraction occurring at approximately 800°C. Needle coke and CSF graphites show the same effect but the contraction of needle coke graphites is approximately 0.6 that of CSF at all temperatures. In the parallel direction, the rates of contraction are the same for both CSF and needle-coke graphites. (auth)

4303 (NP-13321) STUDY OF THE EDGE EMISSION OF CADMIUM SULPHIDE BOMBARDED BY ELECTRONS. Final Technical Report, October 1962–September 30, 1963. (Laboratoire d'Infra-rouge Technique et Appliqué, Gif-Sur-Yvette, France). Contract 62558-3576. 21p.

The luminescence of electron-bombarded CdS and Si is studied at 4900 to 5100 Å, at temperatures of 4 to 77°K. The luminescence spectra are studied with respect to the band structures. (T.F.H.)

4304 (NP-13342) SILICON FIELD EFFECT TRANSISTOR IRRADIATION TEST—2N2386, 2N2497, 2N2498, 2N2499, 2N2500. Lyndon Taylor (Texas Instruments, Inc., Dallas). Mar. 1962. 14p.

The effects of neutrons on silicon field effect transistors are reported. The transconductance of these units probably decreased no more than 50% at 1.5×10^{15} neutrons (E 100 kev)/cm^2. Pinch-off voltage and leakage currents are also reported. (N.W.R.)

4305 (ORNL-3470(p.248-51)) POSTIRRADIATION EXAMINATION LABORATORY. A. R. Olsen (Oak Ridge National Lab., Tenn.).

Construction of the new High Radiation Level Examination Laboratory was completed, and installation of equipment is in progress. For use in the HRLEL, the replication technique was improved and expanded, the ultrasonic cleaning method was modified to permit decontamination of large objects, an improved fission-gas sampler was developed, a pinhole camera for autoradiographs was built, a versatile gamma-ray spectrometer was tested, and two shielded metallographs were installed. Although not yet installed, the HRLEL x-ray diffractometer was used on many samples not requiring shielded loading. The Post-irradiation Examination Group was disbanded, and its functions were transferred to the Operations Division. (auth)

4306 (TID-19501) YTTRIUM HYDRIDE MODERATOR EVALUATION—IN-PILE THERMAL STABILITY. J. C. Marshall, R. Van Houten, W. G. Baxter (General Electric Co. Flight Propulsion Lab., Dept., Cincinnati). Nov. 20, 1962. Contract [AT(40-1)-2847]. 29p. (CONF-11-13; TM-62-11-15)

From American Nuclear Society of 1962 Winter Meeting, Washington, D. C., Nov. 1962.

The stability of a hydrided yttrium–5 weight percent chromium alloy (N_H 5.3 to 5.5) is studied in a nuclear reactor environment at 1000°C for periods greater than 1000 hours (~10^{20} nvt fast). A clad of Fe–20Cr–4.5Al (weight percent) is selected. A method is developed for nondestructively measuring hydrogen content by a neutron-scatter technique. This method allows repetitive monitoring and quantitative measurement of hydrogen loss rates in the same test specimen. Non-nuclear thermal stability is established by a series of bench tests at 980, 1040, and 1100°C in static air, dynamic air (114 ft/sec), and high-pressure air (95 psia). These tests confirm that the specimens are stable for extended periods of time at 1000°C in a non-nuclear environment. Two in-pile tests, each containing four specimens, are performed. The first experiment is run for 1950 hours at 700°C in air for an estimated thermal neutron dose of 4.9×10^{19} nvt. All irradiated specimens remain intact. There are no weight or dimensional changes; nondestructive testing shows that the core, clad, and clad bonds are sound. A chemical analysis on one of these irradiated samples indicates 2.04 weight percent hydrogen. This compares with the 2.00 to 2.08 weight percent hydrogen in the as-hydrided control specimens. The second in-pile experiment uses internal heaters in the cartridge and operates at 1000°C for 2450 hours in air for a total thermal flux of 6.2×10^{19} nvt. A preliminary

evaluation indicates that all specimens are still sound. (auth)

4307 (VDIT-16(3.3)) RADIATION EFFECTS ON SOLID, URANIUM BASED NUCLEAR FUEL MATERIALS. Vol. 3, No. 3. A Bibliography. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Sept. 1963. 43p.

A bibliography of 77 references in abstracted form is presented which is arranged according to the following classifications: general, metallic uranium, alloys, oxide ceramics, carbides and other refractory compounds, and dispersion fuels. Indexes (subject, author, report number, and journal) are included. (D.L.C.)

4308 A LARGE RADIATION-CHEMICAL FACILITY WITH A RADIATION SOURCE FABRICATED FROM SPENT NUCLEAR REACTOR FUEL ELEMENTS. V. L. Karpov, A. Kh. Breger, M. E. Eroshov, V. E. Drozdov, G. N. Lisov, S. G. Stoenko, D. M. Torgovitskii, B. I. Bainshtein, and N. P. Syrkus. At. Energ. (USSR), 15: 302-8(Oct. 1963). (In Russian)

Spent reactor fuel elements are quite suitable for the fabrication of γ sources for large-scale radiation chemical plants, as was demonstrated in the case of elements of the MTR, DIDO, HIFAR, EL-3, and VVR-TS reactors. These elements were usually used for relatively short periods. In order to be able to calculate the much higher γ level of fuel elements used in power reactors for long time periods the average γ production rate, t_p, at the time of their use in the radiochemical plant and the total γ energy released in the reactor, t_r, was calculated for periods of $0 \leq t_p \leq 400$ days and 10 days $\leq t_r \leq 500$ days, using the method reported by E. Crauch (AERA C/M 324, Harwell, July 1957) and assuming that the transportation of the elements from the reactor to the plant requires one day. The dependence of the instantaneous and average γ decay rate of the fuel elements on the length of their use in the reactor and in the irradiation facility was thus determined. In order to verify the results obtained and to gain experience, an industrial-scale irradiation facility was built. The activity was found to drop fast and the units had to be replaced within 100 to 200 days. A dose rate of 800 r/sec was reached in the center of the 12-cm diameter cylindrical elements, using fuel with a total activity of 270,000 gram. equiv. of Ra. A water container was used to hold the unit. (TTT)

4309 ON THE THEORY OF IRRADIATION DAMAGE IN GRAPHITE AT POWER REACTOR TEMPERATURES. R. L. Woolley (Central Electricity Generating Board, Berkeley, Gloschester, Eng.). Brit. J. Appl. Phys., 14: 778-83(Nov. 1963).

A theory of irradiation damage in graphite, based on the interactions of three types of defects, single sessile vacancies, small mobile interstitial clusters, and large sessile interstitial clusters, is developed. Reactions between the mobile and sessile defects occur at random, and lead to expressions for recombination, nucleation, and cluster growth, and to equations for the concentration of the various types of defects as a function of temperature, dose, and flux. These equations are consistent with experimental data on total stored energy and cluster size reported previously. (auth)

4310 A RIG FOR INVESTIGATION OF CREEP OF IRRADIATED URANIUM. A. Bret, R. Marinot, and C. Thomas de Montreville. Bull. Inform. Sci. Tech. (Paris), No. 75, 91-6(Aug.-Sept. 1963). (In French)

An apparatus was designed for studying irradiation creep of uranium. Information gathered by this apparatus will permit a more precise computation of cartridge deformations as, for example, in the first set for the EDF reactors. A probe under load tension is put into a pile; its temperature is made to follow a program independent of the power fluctuations of the reactor. A similar probe is put under identical conditions but out-of-pile; its temperature is made to follow the same cycle. An experimental program for the rig aims to investigate how the creep speed is affected by irradiation and simultaneous thermal cycling. (auth)

4311 TEMPERATURE-REGULATED DEVICE FOR GRAPHITE IRRADIATION. M. Seguin. Bull. Inform. Sci. Tech. (Paris), No. 75, 97-100(Aug.-Sept. 1963). (In French)

An assembly for the irradiation of a large number (1,026) of graphite samples is described. It includes three graphite cylinders suspended in the central channel of the EL-3 reactor; the set temperatures are 150, 250 and 350°C and the accuracy of the regulation is +2°C. It is shown why such an assembly was designed to meet the irradiation requirements. It was found to be very difficult to obtain three different temperatures in one reactor channel. (auth)

4312 EQUIPMENT FOR IRRADIATION AT HIGH TEMPERATURES. 1. 1000°C CAPSULES WITH ELECTRICAL HEATING TEMPERATURE REGULATION. P. Millies and C. Ferrier (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 101-4(Aug.-Sept. 1963). (In French)

Capsules were designed and built at Grenoble for 1000°C irradiations of various samples (uranium carbide, beryllium oxide, and graphite). There are two kinds of capsules, which only differ in their heat transfer capacities: one is the Melusine type: the other is for more powerful reactors (Siloé or HFR). A detailed description of the first types of capsule and some indications about modifications that would make it possible to pass from one type to the other are given. The devices have operated for more than 3000 hours outside the reactor and 2500 hours in the reactor. A few defects observed on prototypes are being studied. (auth)

4313 EQUIPMENT FOR IRRADIATION AT HIGH TEMPERATURES. 2. CAPSULE WITH TEMPERATURE REGULATION USING A VARIABLE COMPOSITION GAS FILM. R. Marfaing. Bull. Inform. Sci. Tech. (Paris), No. 75, 105-9(Aug.-Sept. 1963). (In French)

A capsule for fuel-element irradiation is discussed. With that device, it is possible to adjust the power generated in the sample by moving the capsule and to obtain the expected temperature by changing the proportions of two gases (helium and nitrogen) in a gap which is a thermal barrier. The advantages and limits of such a device are examined. (auth)

4314 EQUIPMENT FOR IRRADIATION AT HIGH TEMPERATURES. 3. 2000°C IRRADIATION FURNACE. A. Briand (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 111-13(Aug.-Sept. 1963). (In French)

A furnace for irradiation of refractory fuels at 2000°C was designed and built at Grenoble. The device includes instrumentation for measuring fission products released by the irradiated sample. Heating is supplied by a high-frequency induction circuit. Temperature is measured at the hot spot with a tungsten-rhenium thermocouple. Three prototypes were made; the second was tested in various ways, and has undergone two operations of 60 and 250 hours; one 1000 hour test is being made. (auth)

4315 IRRADIATION OF INDIUM ANTIMONIDE AT 78°K WITH NEUTRONS AND γ RAYS. Costas Georgopoulos, Max Verdone, and Daniel Cautreppe (Centre d'Etudes Nucléaires, Grenoble, France). Compt. Rend., 257: 2640-3 (Oct. 28, 1963). (In French)

Irradiation in a swimming pool reactor of InSb emphasized a very important effect caused by γ radiation. After reactor irradiation or irradiation with Co^{60} γ rays, five anneal states are found. The first two states are attributed to the recombination of neighboring pairs. The kinetics of state II is of the first order and the activation energy is 0.62 ± 0.002 ev. (tr-auth)

4316 ON THE CREEP PROBLEM IN THICK CYLINDRICAL PIPES SUBJECTED TO INTERNAL PRESSURE AND NEUTRON IRRADIATION. M. A. Zadoyan (Inst. of Mathematics and Mechanics, Academy of Sciences, Armenian SSR). Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 16: No. 4, 73-8(1963). (In Russian)

An analysis was made of ductility and plasticity in long, thick-walled, cylindrical pipes subjected simultaneously to constant neutron irradiation and internal radial pressure. (R.V.J.)

4317 FRICTIONAL PROPERTIES OF IRRADIATED POLYMER AT ELEVATED TEMPERATURES. Kiyoshi Matsubara and Makoto Watanabe (Government Mechanical Lab., Tokyo). Nippon Kikai Gakkai Rombunshu, 29: 1102-11(June 1963). (In Japanese)

A study of the frictional behavior of irradiated high density polyethylene over a temperature range of 20 to 200°C is described. It is found that the coefficient of friction μ increases with increasing temperature until about the melting point of this material (the first stage), and above the melting point it decreases to a constant value (the second stage). As an example μ of the highest-irradiated specimen increases at first from 0.4 up to 0.6, and above the melting point it decreases to 0.15. The phenomenon of the first stage becomes more remarkable with increasing radiation dose, but the constant low value of μ at the second stage seems independent of radiation dose. It is suggested that the frictional behaviors of the irradiated polymer at elevated temperatures may be explained not by the decrease of adsorbed gases on the sliding surface or the change of S/P (S is shearing strength and P is hardness or yield pressure) of the polymer, but by a deformation factor in sliding friction which was previously described by Tabor. The deformation factor probably consists of the loss caused by the relative displacement of crystallites of polymers surrounded by network chains, which have been produced by irradiation. (auth)

4318 STUDY ON EFFECTS OF γ-RAY IRRADIATION ON POLYETHYLENE BY A VIBRATION METHOD. Jobu Awatani and Matsuo Minegaki (Osaka Univ.). Nippon Kikai Gakkai Rombunshu, 29: 1189-96(July 1963). (In Japanese)

Young's modulus of γ-irradiated polyethylene was measured by a vibration method. Effects of radiation dose, the atmosphere in which irradiation is done, the thickness of samples irradiated, and other factors acting on crosslinking were studied. Results indicated that the degree of crosslinking in samples irradiated in vacuum is remarkably larger compared with that irradiated in air. The thinner the samples, the lower the degree of crosslinking. For thin samples irradiated in air, the proportional relation between the degree of crosslinking and radiation dose is not held. Irradiation has complicated, rather harmful, effects on the mechanical properties such as yield, stress, and wear resistance. (auth)

4319 REACTION KINETICS ANALYSIS OF THE ENERGY RELEASE OF IRRADIATED GRAPHITE. M. Kaltenbrunner, R. Sizmann, and H. Wenzl (Technische Hochschule, Munich). Nukleonik, 5: 269-74(Oct. 1963). (In German)

The energy release of irradiated graphite was measured in a heat calorimeter with heating linear with time between 50 and 450°C. From the measurement curve a general statement of the activation enthalpy, U, could be determined. Over the total recovery region, a constant value, U = 1.8 ± 0.1 ev, was obtained. An examination of the source of energy release in relation to time showed that the model of the elementary processes with a reaction equation of first or second order and a diffusion-limited reaction rate under consideration could not be applicable. This condition, in addition to the fine structure of the recovery curve and results of other authors, shows that the energy release in the observed recovery region is correlated with a complex defect mechanism. (tr-auth)

4320 THE ANNEALING OF DISLOCATION LOOPS IN NEUTRON IRRADIATED COPPER. M. J. Makin and S. A. Manthorpe (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 8: 1725-38(Oct. 1963). (AERE-R-4355)

Transmission electron microscopy was used to measure the density of defect clusters and loops of various sizes in neutron irradiated copper as a function of annealing. Quantitative measurements show that recovery occurs at ~300°C in two stages. In the first of these the density of the larger clusters (>50 Å diameter) is greatly reduced, the process occurring in a few tens of minutes at 275°C with an apparent activation energy of ~1 ev. In the second stage of recovery, which occurs in several thousand minutes at 275°C, the small clusters (<50 Å diameter) and the remaining larger loops disappear with an apparent activation energy of ~2 ev. The first stage is attributed to the thermal dissociation of submicroscopic vacancy clusters and the consequent annihilation of a large proportion of the interstitial atoms present in the larger loops. Also, in this stage the larger vacancy clusters increase in size and stability. The second stage is the dissociation of these larger vacancy clusters and the annihilation of the remaining interstitial loops. The shape of the loop size distribution can be predicted throughout the annealing by a simple model in which each interstitial loop, irrespective of size, collects the same number of vacancies during a given annealing. (auth)

4321 THE EFFECT OF QUENCHED-IN VACANCIES OF STAGE I RECOVERY OF NEUTRON-IRRADIATED GOLD AND ALUMINIUM. M. L. Swanson and G. R. Piercy (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Letters, 7: 97-9(Nov. 1, 1963).

An attempt was made to clarify the anomalously low stage I recovery in irradiated gold. The first part of stage I for any metal is thought to be due to the recombination of close Frenkel pairs and the latter part due to the migration of interstitials or crowdions. Aluminum was chosen as a metal possessing normal stage I recovery. (R.E.U.)

4322 THE RECOVERY OF NEUTRON-IRRADIATED ZINC. J. Nihoul (SCK-CEN, Mol. Belg.). Phys. Status Solidi, 3: 2061-8(1963).

The recovery of the electrical resistivity of pure zinc was investigated after neutron irradiation at liquid nitrogen temperature. The main recovery stage was located around 105°K. Two independent analytical methods pointed to an activation energy of about 0.21 ev and second order kinetics. This stage was ascribed to the migration of interstitials to vacancies and may be compared with stage III of the fcc and bcc metals. A second, but less pronounced, recovery stage around 155°K is associated with an activation energy of 0.50 ev and may be due to vacancy migration. (auth)

4323 METHODS FOR RADIATION HARDENED CIRCUIT DESIGN. D. C. Latham (Martin Co., Baltimore). 3p. (CONF-326-1)

From 7th National Convention on Military Electronics, Washington, D. C., Sept. 1963.

Design techniques for electronic systems operating in radiation environments are discussed. Radiation from nuclear weapons and in space exploration is considered. (R.E.U.)

4324 OPTICAL PROPERTIES OF THERMAL NEUTRON INDUCED CADMIUM NUCLEAR RECOIL DEFECTS IN CADMIUM SULFIDE. R. Oswald and C. Kikuchi (Univ. of Michigan, Ann Arbor). 10p. (CONF-78-19)

From American Physical Society 1963 Summer Meeting, Buffalo, June 1963.

Preliminary results of the experimental study of the effects of thermal neutron-induced Cd^{114} recoil on the photoconductivity and luminescence in cadmium sulfide are presented. Cadmium vacancy and interstitial defects in CdS are created by the recoil of Cd^{114} through the reaction $Cd^{113}(n_{th},\gamma)Cd^{114}$. Measurements of the luminescence spectra under uv excitation at 77°K before and after neutron irradiation shows that a broad red band centered at 7200A is produced, thus suggesting that the red emission at 7200A is related to either cadmium interstitial or vacancy defects. A less pronounced change in the 5200A luminescence is produced. Measurement of the photoconductivity before and after thermal neutron irradiation indicates that Cd^{114} recoil produces a decrease in the conductivity of initially conducting samples. (auth)

PHYSICS

General

4325 (CONF-76-7) THE USE OF INFRARED LASER RADIATION FOR SPECTRAL SLIT WIDTH STUDIES. H. W. Morgan, P. A. Staats, P. M. Griffin, K. L. Vander Sluis, and G. K. Werner (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 22p.

From Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio, June 1963.

An infrared-emitting gas laser was used to provide a continuously operating monochromatic source of constant intensity with conveniently spaced wavelengths. The exit slit response is considered as a separate factor in the compensation for spectral slit width in high-resolution spectroscopy. (R.E.U.)

4326 (LA-2974) AN INTEGRATED SERIES OF CRYSTALLOGRAPHIC COMPUTER PROGRAMS. I. CRYSTAL ORIENTATION. Allen C. Larson, Don T. Cromer, R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). Sept. 1963. Contract W-7405-eng-36. 34p.

The procedures employed and the computer program used for the determination of single crystal orientation prior to intensity measurements are described. (auth)

4327 (LADC-5862) A PROPOSED MECHANISM FOR SHOCK INITIATION OF LOW-DENSITY GRANULAR EXPLOSIVES. L. B. Seely (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 48p. (CONF-341-1)

From 4th Electric Initiator Symposium, Philadelphia, Oct. 1963.

An investigation was conducted on the role of the interstitial gas in the shock ignition of granular explosives. From the results, it is proposed that the ignition mechanism lies in stagnation hot spots which occur against the surface of the downstream grains. (D.L.C.)

4328 (NP-13361) MASS SPECTROGRAPHIC LINES OF THE ELEMENTS. Technical Report No. 265. E. B. Owens and A. M. Sherman (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Apr. 3, 1962. 211p.

The lines observable by r-f spark ionization of inorganic solids in a Mattauch-Herzog double-focusing mass spectrograph are tabulated. Arrangement by element presents the lines for each in order of their increasing apparent mass. For all the known naturally occurring isotopes, the tables delineate: ions with charge of +1 through +9, multiatomic clusters containing from one to ten atoms, and eight of the more frequently occurring charge-exchange combinations. Each entry gives the isotope and element identification, a coded explanation of the line formation, the apparent mass and square root of the apparent mass to nine significant figures (when the mass is known to this accuracy), and the relative abundance. The tables, because they are arranged by element, aid in identifying rapidly all lines due to the major elements of the sample and in confirming or rejecting tentative identifications much more conveniently. (auth)

4329 (ORNL-3470(p.237-9)) THERMONUCLEAR PROJECT. R. E. Clausing (Oak Ridge National Lab., Tenn.).

The sorption of seven gases by four types of vapor-deposited titanium, used in high-vacuum getter pumping, was measured and interpreted. For the manufacture of high-quality magnets, high-performance superconducting joints are being developed and other aspects of the metallurgy of superconductors are being studied. (auth)

4330 (TID-19744) SOLID STATE INVESTIGATIONS UTILIZING ELECTRON-BOMBARDMENT PHENOMENA. Annual Progress Report for 1963. Martin A. Pomerantz (Bartol Research Foundation, Swarthmore, Penna.). Nov. 15, 1963. Contract AT(30-1)-2730. 56p.

The investigations of the post-bombardment conductivity in single MgO crystals were continued. Measurements of thermally stimulated conductivity following bombardment were used to identify the number of trapping levels contributing at different temperatures. The time dependence of the conductivity was fitted to a theoretical model, and the results were used to determine the depth of the trapping levels. The discrepancy between the saturation behavior of the electron-bombardment-induced conductivity and that of the alpha-particle-induced conductivity in diamond is discussed. Results of a pulse height analysis of the output from alpha-particle-bombarded diamond support the hypothesis that was suggested to explain the discrepancy. A semi-phenomenological theory of the superconducting phase is proposed and used to derive principal magnetic and transport properties. A theory of the dynamical properties of low-mobility carriers in dielectric materials is formulated. Difficulties in extending the binary kernel formulation of the Heisenberg model of ferromagnetism to higher temperatures are described. (D.L.C.)

4331 (FTD-TT-63-381) THE HYDRODYNAMICS OF AN EXPLOSION. Yu. S. Yakovlev. Translation of "Gidrodinamika Vzryva" (a publication of the State Publishing House of Literature on Literature on Ship Construction, Leningrad, 1961). 343p.

A text is presented in which are studied: the propagation of shock waves; explosions in unbounded media; boundary problems in explosion theory; and the problem of external forces in the case of aerial and underwater explosions. (T.F.H.)

4332 (NASA-TT-F-73) ELECTRON AND ION EMISSION. L. N. Dobretsov. Translation of "Elektronnaya i Ionnaya Emissiya" (a publication of State Publishing House for Technical and Theoretical Literature, Moscow-Leningrad, 1952). 348p.

A collection of Russian studies in the field of physical electronics, covering the appearance of charged particles (electron and ion emission), their motion in a vacuum or a very rarefied gas (electron or ion optics), and their disappearance at electrodes, is presented. The results of the investigations and the theoretical explanation of the phenomena studied are examined. In a number of cases, the results of the investigations are given in the form of diagrams, rather than in the form of graphs taken from the original works. (auth)

4333 STATISTICAL AND THERMODYNAMICAL DESCRIPTION OF CORRELATED SYSTEMS. IV. TIME-DEPENDENT DISTRIBUTIONS. Andrzej Fulinski (Jagellonian Univ., Krakow). Acta Phys. Polon., 24: 143-51 (Aug. 1963).

The solution of master equations describing the evolution in time of correlated subsystems forming an isolated system is given. It is found that near the equilibrium or stationary state the probabilities of finding of the subsystems

in their quantized states and the correlation coefficients are the exponential functions of momentary values of observables, and do not depend on the initial state of the system. (auth)

4334 STATISTICAL AND THERMODYNAMICAL DESCRIPTION OF CORRELATED SYSTEMS. V. PHENOMENOLOGICAL EQUATIONS NEAR BY EQUILIBRIUM. Andrezej Fuliński (Jagellonian Univ., Krakow). Acta Phys. Polon., 24: 153-64(Aug. 1963).

The phenomenological equations for time-changes of entropies and of observables are obtained from time-dependent statistical probability distributions. It is found that there are two possible and admissible ways of phenomenological description of irreversible processes: (i) from the point of view of the whole isolated system, or (ii) from the point of view of a single non-isolated subsystem. These descriptions are not equivalent: in (i) one finds different formulas for the rates of irreversible changes than in (ii), i.e., the fluxes are found to be caused by different causes in different descriptions. It is also found that irreversible processes occurring in both subsystems can influence each other. (auth)

4335 THE EFFECT OF THE SHAPE OF THE SHIELDING BARRIER ON THE ATTENUATION OF γ-RADIATION OF VOLUME SOURCES. D. P. Osanov. At. Energ. (USSR), 15: 331-2(Oct. 1963). (In Russian)

The efficiency of flat shields could be improved by surrounding volume sources with a shield, the surface of which follows the contours of the source. In order to gain more knowledge in this field, the attenuation of γ radiation emitted by a cylindrical source was determined inside of a cylindrical shielding layer; in view of the difficult computations, a direct experimental method was used. Lead sheets were given a cylindrical shape with increasing radii of curvature and these shields were placed directly against the container filled with $Co^{60}SO_4$ solution or against another shield. The attenuation of the radiation was measured using these cylindrical sheets or the usual flat sheets. The difference between the 2 attenuation curves was 30% at a Pb thickness of 2 cm, increasing to 120% for the 10-cm thick layers. Thus, use of cylindrical shields for high-activity volume sources results in a considerable saving in the thickness and therefore in the weight of the shield. (TTT)

4336 A NATURAL DIMENSION SYSTEM FOR ENERGY ANALYSIS. E. Beynam. Atomkernenergie, 8: 371-3 (Oct. 1963). (In German)

The system of the dimensions length–energy–charge has advantages, which can render good services in presentation and interpretation. Some cases are described. (auth)

4337 DIRECT DETERMINATION OF SCATTERING PHASE SHIFTS FROM DIFFERENTIAL CROSS SECTIONS. J. W. Brackett, C. R. Mueller, and W. A. Sanders (Purdue Univ., Lafayette, Ind.). J. Chem. Phys., 39: 2564-71 (Nov. 15, 1963).

As the first step in the analysis of molecular beam scattering data, a computational method was developed for the determination of the asymptotic phase shifts from the differential cross sections. The phase shifts were represented by a linear combination of two Gaussian functions and an exponential function, and the parameters of the empirical function were determined from a least-squares fit of the observed cross sections. The computational time required was less than 10 sec per iterative cycle on the IBM 7090 computer. In order to obtain a unique fit of the positive phase shifts, it was necessary to use data from a range of scattering angles wide enough to include at least the first minimum and second maximum of the differential cross sections. (auth)

4338 DIRECT DETERMINATION OF INTERMOLECULAR POTENTIAL PARAMETERS FROM SCATTERING PHASE SHIFTS. W. A. Sanders and C. R. Mueller (Purdue Univ., Lafayette, Ind.). J. Chem. Phys., 39: 2572-80 (Nov. 15, 1963).

Numerical methods were developed for the direct determination of the parameters of intermolecular potential functions from scattering phase shifts, using the WKB expression for the phase shifts. Four potential functions were investigated, ranging in sophistication from the simple square-well model to a function with five adjustable parameters. Although the complexity of the calculations increased as the potential function became more complicated, the availability of an IBM 7090 computer made it possible to use numerical methods with considerable success. The computing time was reduced to less than 15 sec per iterative cycle for the five-parameter potential. (auth)

4339 RENORMALIZATION OF THE IDEAL SPIN-WAVE THEORY TO TEMPERATURE. Endre Praveczki. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 355-83(1963). (In Hungarian)

A new approach for the interpretation of ferromagnetism is obtained by renormalizing the fundamental relations of the spin-wave theory in order to obtain results of the same form as those obtained by the Green's function method. The so renormalized ideal spin-wave theory lends itself for the expression of quantities containing contributions of higher order correlation functions. The expressions thus obtained are compared with similar theoretical results. (auth)

4340 SURFACE DIFFUSION PHENOMENA IN GASEOUS DIFFUSION. I. SURFACE DIFFUSION OF PURE GAS. Kunio Higashi, Hiroo Ito, and Jun Oishi (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 5: 846-53 (Oct. 1963).

The surface diffusion in localized monolayers is discussed. The surface diffusion phenomena are regarded as the random walk of the so-called "hopping molecules" on a solid surface. It is assumed that when a molecule adsorbed in a site jumps to one of the nearest neighbor sites, the molecule can jump to any one of them whether it is vacant or not, and if the site to which a molecule jumps was already occupied, the molecule is not bound to this site but collides with the former occupant and scatters isotropically. On the basis of this new model for surface diffusion mechanism, the approximate relation between surface diffusion coefficient and coverage is introduced. The proposed new model is examined by various experimental data, and some of the approximations and assumptions used in the model are discussed. (auth)

4341 THE PENETRATION OF ENERGETIC IONS THROUGH THE OPEN CHANNELS IN A CRYSTAL LATTICE. R. S. Nelson and M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 8: 1677-90(Oct. 1963). (AERE-R-4262)

In studying the transmission of 75-kev protons through thin crystals of Au, penetration was found to be greatly enhanced when ions were incident along ⟨110⟩ directions. In another experiment, the reflection of 50-kev H^+, He^+, Ne^+, and Xe^+ ions from the {110} surface of a Cu crystal was found to diminish sharply whenever incidence occurred along low-index directions or parallel to low-index planes. The results of these two experiments are con-

sidered as evidence for the easy passage of ion trajectories along open channels in the crystal lattice. Two types of channel are thought to exist in fcc lattices, those formed in two dimensions between adjacent close-packed planes of atoms, and those between rows of atoms in a particular direction. The experiments suggest the most favored in the first category to be between {111} or {100} planes, and in the second category between the {110} or {100} rows. It is shown that channeling could occur as the result of a series of glancing collisions with atoms on the lattice. These introduce an effective potential well across the channel which reflects the ion trajectory back and forth as it passes through. In the case of light ions it is predicted that a square well potential is a good approximation, and this is borne out by the observations. The slowing down of the lighter ions in channels is predominantly due to collision with electrons. Ranges in the channels are expected to be enhanced in the ratio of the average electron density in the crystal to that along the channel. Observations show that radiation damage to the lattice can block the channels and prevent long trajectories. (auth)

4342 A STUDY OF CONDUCTION ELECTRON POLARIZATION IN FERROMAGNETIC GADOLINIUM USING PERTURBATION OF γ-γ CORRELATIONS. S. G. Cohen, N. Kaplan, S. Ofer, and H. Zmora (Hebrew Univ., Jerusalem). Phys. Letters, 7: 91-2(Nov. 1, 1963).

Lutetium nuclei, within trivalent lutetium ions, situated as dilute impurities in ferromagnetic gadolinium were used as a probe to estimate the local polarization of the conduction electrons. The sign and magnitude of the magnetic field acting on the lutetium nuclei were obtained using the technique of measuring the perturbation of the angular correlation of a cascade of nuclear γ rays. The magnetic field at the dilute lutetium nuclei was found to be -1.8×10^5 oersted at 87°K, extrapolating to -2.0×10^5 oersted at magnetic saturation, the negative sign indicating a field opposite to the gadolinium magnetization. (R.E.U.)

4343 CONDITIONS FOR STABLE EQUILIBRIUM OF SYSTEMS AT NEGATIVE ABSOLUTE TEMPERATURES. V. Vyšín (Palacký Univ., Olomouc, Czechoslovakia). Phys. Letters, 7: 120-2(Nov. 1, 1963).

The conditions for stability of the spin system at positive and negative absolute temperatures are discussed. It is concluded that a thermodynamical system may exist in an equilibrium state at negative absolute temperatures and the condition for stability of this system is connected with the positive (at positive absolute temperatures) or negative (at negative absolute temperatures) definition of the quadratic form $\delta^2 E$, which is the second variation of the internal energy. (R.E.U.)

4344 THE HYPERFINE STRUCTURE OF Fe^{57} IN $FeC_2O_4 \cdot 2H_2O$. F. De S. Barros, P. Zory, and L. E. Campbell (Carnegie Inst. of Tech., Pittsburgh). Phys. Letters, 7: 135-6(Nov. 1, 1963).

The Mössbauer absorption spectra were investigated in ferrous oxalate ($FeC_2O_4 \cdot 2H_2O$) at room temperature to liquid helium temperature. The energy level scheme for the ground and excited states of Fe^{57} at 4°K and the calculated eigenfunctions for each level are given. (R.E.U.)

4345 ON THE COLORATION LAYER IN DEUTERON-IRRADIATED LiF CRYSTALS. P. Goerlich, H. Karras, and G. Koetitz. Phys. Status Solidi, 3: 2029-34(1963).

Synthetic LiF crystals grown in high vacuum were irradiated with 13.5-Mev deuterons. The colored layer was removed in 34 steps and the coloration spectrum measured after each step. No qualitative differences in the coloration spectra at different depths could be established. A method for the determination of the thickness of the colored layer is described and used to measure the thickness of the layer for the strongest coloration bands at 248 (F band), 445 (M band), 316 (R_1 band), and 378 nm (R_2 band). The mean value of the average range was about (0.655 ± 0.001) mm. The thickness of the colored layer is shown to be related to the depth of penetration of the deuterons. (auth)

4346 MOLECULAR BEAM PRODUCTION WITH NOZZLES IN PULSE OPERATION. Otto-Friedrich Hagena (Kernforschungszentrum Karlsruhe, Ger. and Technische Hochschule, Karlsruhe, Ger.). Z. Angew. Phys., 16: 183-7(Sept. 1963). (In German)

In pulsed molecular beam experiments the apparatus can be significantly reduced if the gas input is interrupted instead of interrupting the beam. By measuring the transient pattern on various pulse lengths, it was determined how fast and over what intermediate states the intensity reaches an equilibrium after pulse initiation. The manner in which the pressure, increasing the pulse length in the first pressure stage, affects the intensity of the molecular beam pulse was also determined. A magnetically operated quick acting gate valve was used for pulse production. The shortest pulse produced had a length of 1.6 msec. (tr-auth)

4347 INTERMOLECULAR POTENTIALS AND THEIR RELATION TO MOLECULAR BEAM SCATTERING DATA. Raymond Paul Marchi. Thesis, Lafayette, Ind., Purdue Univ., 1963. 141p.

The application of the WKB approximation using the Langer modification to calculate differential cross sections was investigated. Integrals were evaluated using Weddle's rule and intervals of integration from 0.02 to 0.10 A. The approximation was found to work extremely well for values of $K = (\mu v^2/2\epsilon) \geq 1.0$, where ϵ is the depth of the potential well. As the value of K decreases, the agreement decreased. For values of $K \leq 0.8$ care must be excercised in its application in cases corresponding to classical orbiting. By varying the two Lennard-Jones (12,6) potential parameters, ϵ and σ, the sensitivity of the potential to the differential cross sections, $d\sigma/d\Omega$, was determined. An increase of 10% in ϵ caused approximately a 10% increase in $d\sigma/d\Omega$; a 10% increase in σ produced a 25% increase in $d\sigma/d\Omega$. Unsuccessful attempts were made to fit F. Knauer's experimental differential cross section data on the H_2–Hg and He–Hg systems using a 12-6 potential. In order to fit the data preliminary results indicate that the potential well must be broadened and the coefficients of $1/r^6$ must be increased at large distances. Work on the modified potentials indicated that some empirical relationships between the potential and phase shifts might exist that would simplify the inversion problem. Velocity-averaged differential cross sections were computed for the H_2–Hg and He–Hg systems by averaging over 18 and 11 velocities respectively. Small oscillations in $d\sigma/d\Omega$ should be observable at large scattering angles. The results clearly indicate that Knauer's data could not be reproduced with a Lennard-Jones potential. The quantum analogue of classical rainbow scattering was computed for the K–Hg system by averaging the differential cross sections over three velocities. Cross sections were determined using 550 phase shifts. In place of the classical discontinuity, quantum theory predicts a minimum followed by a maximum with the maximum occurring at a slightly smaller scattering angle than the classical discontinuity. Calculations were also made on systems of identical particles. The calculations are slightly more complex but do not differ significantly from those of distinguishable particles. Total

cross sections were calculated for several systems (H_2–Hg, H_2–H_2, He–Hg, He–He) as a function of velocity. As the velocity decreases, there is a gradual increase in the total cross section followed by a minimum, a rapid increase and then a sharp maximum. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4348 ADVANCED PROPULSION CONCEPTS. VOLUME I. [Proceedings of Third Symposium, 2-3-4 October 1962, Cincinnati, Ohio]. New York, Gordon and Breach Science Publishers, 1963. 439p. $29.50.

The Proceedings of the Third Symposium on Advanced Propulsion Concepts includes opening and concluding remarks and 17 papers on ion and electrothermal propulsion, plasma propulsion, electrostatic acceleration of neutral plasmas, space power, nuclear fission propulsion concepts, and nuclear fusion propulsion concept. Separate abstracts have been prepared for 14 papers, and 2 were abstracted previously in NSA. (M.P.G.)

For abstracts of individual papers see: 4349, 4350, 4351, 4352, 4353, 4354, 4426, 4427, 4664, 4665, 4666, 4667, 4840, and 4841.

4349 THE ELECTRON-BOMBARDMENT ION ROCKET. Harold R. Kaufman (Lewis Research Center, Cleveland). p.3-18 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

An evaluation of the electron-bombardment ion rocket for space propulsion is presented. The problems associated with the ion chamber, magnetic field, cathode, accelerator, and neutralizer and with scaling from model to full size are discussed. Performance estimates are made. A minimum power-to-thrust ratio of ~150 kw/lb can be obtained at a specific impulse of ~4000 sec. The performances of engines using Cs or Hg as propellants were found to be essentially equivalent. Research on the basic engine should be completed within a year and should then be directed to the system problems of multiple engines. (M.P.G.)

4350 QUEST FOR HEAVY PARTICLE ELECTRIC PROPULSION. R. E. Hunter (Propulsion Lab., Wright-Patterson AFB, Ohio). p.19-33 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

Although the primary motivation for heavy-particle electrical-propulsion research is the attainment of efficient operation in the intermediate range of specific impulse (1000 to 5000 sec), the concept gives promise of efficient operation at any desired specific impulse. The many approaches being pursued are not without practical problems, but the accomplishments to date justify continued enthusiasm. The present-day problems of charge/mass ratio distribution (including ionic current and neutral loss), low source current, and agglomeration will all be overcome in time. It remains only to be shown what compromises must be made in order to achieve a usable thrustor and then to make comparisons with other thrustors to determine competitiveness. (auth)

4351 STL HEAVY PARTICLE PROPULSION PROGRAM. Ernest Cohen (Space Tech. Labs., Los Angeles). p.35-51 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

Colloidal charged droplets are of interest for electrostatic propulsion, since they permit the use of higher voltages and provide specific impulses in the range of 2000 sec. Droplets of metallic and organic liquids were formed from the bulk liquid by passing the liquid through a capillary metal tube held at a high potential. Charge/mass determinations were made using a single-particle detector or a Massenfilter, which uses a time-dependent electric quadrupole field to pass a narrow band of charge/mass ratio droplets. Experimental results and problems are reported. The organic liquids with ionic conductors, such as glycerol and antimony trichloride, and the low-melting-point metals, such as Woods Metal, were found to be the most promising. (M.P.G.)

4352 CONDENSATION COLLOID PROPELLANTS FOR ELECTROSTATIC PROPULSION. A. Lucille Cox (Ion Physics Corp., Burlington, Mass.). p.53-73 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The controlled-growth colloidal ion source, to produce colloidal particles with a high uniform charge-to-mass ratio, is described. The ion source utilizes the following processes, each of which is discussed: ionization of a small fraction of the molecules in a vapor; gas expansion through a nozzle; formation of stable, charged condensation nuclei; growth of the charged nuclei by condensing collisions; radiation of some of the heat of condensation; and control of the growth process by controlling ion velocities with an electrostatic field. Three types of ionizers, which have been studied experimentally, are the contained arc, the free arc, and the corona ionizer. The free arc and corona ionizers appear to be the most promising, but electrons must be completely removed from the beam and space-charge forces must be canceled to obtain the required current densities. (M.P.G.)

4353 IMPULSIVE MHD DEVICES AS SPACE ENGINES. R. H. Lovberg (General Dynamics-Astronautics and General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.95-113 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The problems associated with the development of a coaxial-cylinder plasma gun into an efficient rocket engine are discussed. The mechanism of plasma acceleration is described. Collisions between ions and electrons cause energy losses, which may be reduced by accelerating the plasma during a short period of time or in a short gun. Instabilities in the plasma configuration are formed easily, but they are not inevitable. The design and performance of an experimental coaxial plasma accelerator is described. Efficiency was found to be low, but that is due primarily to the "crowbar" effect, a secondary discharge after ~½ cycle of the oscillating gun current. Proper choice of initial propellant distribution and insulator configuration may prevent the effect. The problem of obtaining long-lived and reliable components is also unsolved at the present time, but first the essential feasibility of the method must be shown with laboratory models. (M.P.G.)

4354 MOMENTUM TRANSFER THROUGH THE ELECTRIC FIELDS. R. G. Meyerand, Jr. (United Aircraft Corp. Research Labs., East Hartford, Conn.). p.177-97 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

It has been shown that a self-consistent condition may exist in which a nonthermal electron energy distribution results in the existence of an electrostatic gradient in a plasma. The ion acceleration is obtained through momentum transfer from electron reflections in the space-charge neutral plasma. In a practical device, the electron momentum can be transferred through a magnetic mirror at the

rear of the engine coupling the ion thrust to the engine structure in an efficient manner. In addition, the use of a purely radial magnetic field space-charge neutral-ion accelerator gives promise of an alternate method for the production of high-current space-charge neutral ion beams. Experimental investigations and the performance of a laboratory-model rotating-electron ion engine are discussed. (auth)

4355 ON THE THEORY OF RESONANT SCATTERING OF GAMMA RAYS BY NUCLEI BOUND IN CRYSTALS. R. L. Mössbauer and D. H. Sharp (California Inst. of Tech., Pasadena). 24p. (CONF-303-11)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

A physical description is given of the process in which a gamma quantum is resonantly scattered or absorbed by nuclei bound in a crystal. A discussion is given of the time development of these processes and the limits imposed by the laws of quantum mechanics. (R.E.U.)

4356 WORK-FUNCTION MEASUREMENTS AND LATTICE DEFECTS. J. A. Dillon, Jr., and R. M. Oman (Brown Univ., Providence). 14p. (CONF-209-7)

From American Vacuum Society Meeting, Boston, Oct. 1963.

Work-function or photoelectric threshold values of atomically clean surfaces can in some instances be markedly influenced by the nature and density of lattice defects near the surface. Such defects can result from the method of surface formation or can be deliberately introduced by a process such as ion bombardment. As an example, the work functions of certain crystal faces of niobium can be decreased by 0.5 ev due to argon ion bombardment. Variations of this type for a number of materials are summarized and compared, and possible explanations for the effects are discussed. (auth)

4357 MÖSSBAUER EFFECT IN FeS_2. A. A. Temperley and H. W. Lefevre (Univ. of Oregon, Eugene). 9p. (CONF-303-7)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

The quadrupole splitting and isomer shift of the 14.4-kev level of Fe^{57} in the pyrite and marcasite structure of FeS_2 were studied using recoilless resonant absorption techniques. A single, unsplit emission from a source was obtained by annealing 1 mc of Co^{57} on a copper foil. (R.E.U.)

4358 BLOCH ELECTRONS IN A UNIFORM MAGNETIC FIELD. E. Brown (Rensselaer Polytechnic Inst., Troy, N. Y.). 23p. (CONF-23-21)

From American Physical Society, 1963 March Meeting, St. Louis, Mar. 1963.

The physical periodicity of a space lattice is not destroyed by the presence of a uniform magnetic field. It is shown that a ray group of unitary operators, isomorphic to pure translations, commutes with the hamiltonian in this case. Such a group has the characteristic property that $AB = \exp[i\Phi(A,B)]C$, where A,B, and C are elements of the group and Φ is a numerical factor. Representation theory applied to this group yields the characteristic degeneracies of levels in magnetic fields, as well as the transformation properties of eigenfunctions. By means of these it is possible to construct an effective hamiltonian appropriate to finite magnetic fields in crystals. (auth)

4359 MAGNETOHYDRODYNAMIC SHIP PROPULSION USING SUPERCONDUCTING MAGNETS. R. A. Doragh. 13p. (CONF-318-2)

From The Society of Naval Architects and Marine Engineers Annual Meeting, New York, N. Y., Nov. 1963.

Marine propulsion using a screw propeller cannot couple large amounts of power quietly to sea water. One possible substitute for the propulsion method which does not have this disadvantage is the magnetohydrodynamic (MHD) pump-jet. It is demonstrated that the MHD pump-jet is technically interesting with high magnetic fields. The efficiencies of propulsion are of the order of 60 percent for ten webers per square meter and are primarily dependent on pump-inlet velocity and magnetic-flux density. The optimum geometry associated with this device is reasonable and relatively insensitive to speed changes. The principal limiting losses in the device are hydraulic losses and, therefore, any design should attempt to minimize these. If the MHD pump-jet is to achieve its theoretical characteristics, four general problem areas must be studied: (a) The fabrication of better superconductors to be used to generate very high magnetic fields. (b) The development of a control system to insure efficient variable-speed operation and coil protection. (c) The development of a gas exhaust system to minimize any bubble sound source. (d) The development of an optimum dewar and cryostat that will maintain the proper temperatures efficiently. In each of the above areas, a possible solution is given and discussed. In addition, possible variations on the studied system are offered. (auth)

4360 SPUTTERING MECHANISMS. S. P. Wolsky (P. R. Mallory & Co., Inc., Burlington, Mass.). 27p. (CONF-209-8)

From American Vacuum Society Meeting, Boston, Oct. 1963.

The current state of knowledge of sputtering mechanisms is indicated through a discussion of several important aspects of sputtering phenomena currently being investigated. The main topics considered are sputtering thresholds, sputtered atom ejection patterns and velocities, the sputtering of compounds, and sputtered thin films. Recent experimental and theoretical approaches to sputtering are also discussed. 40 references. (auth)

4361 PARTICLE SEPARATION APPARATUS UTILIZING CONGRUENT INHOMOGENEOUS MAGNETOSTATIC AND ELECTROSTATIC FIELDS. Benjamin Bederson, Joseph Eisinger, and Kenneth Rubin (to Bell Telephone Labs., Inc.). U. S. Patent 3,113,207. Dec. 3, 1963. Filed Mar. 1, 1960.

An apparatus for selecting from a beam of particles those of a particular magnetic substate is described. The deflection system utilizes congruent inhomogeneous magnetic and electric fields. It is possible to adjust the magnetic and electric deflection forces so that they are balanced for particles of a given magnetic substate, but unbalanced for all others. By passing a beam through such a deflection system there can be deflected and thereby separated from the beam all particles other than those of the chosen magnetic substate. (M.C.G.)

Accelerators

4362 (LNF-63/46) L'ACCELERATORE LINEARE PER ELETTRONI E POSITRONI. (The Electron and Positron Linear Accelerator). Note No. 206. F. Amman and R. Andreani (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 1, 1963. 44p.

The electron and positron linear accelerator being con-

structed at Frascati is described in some detail. The theory of linear accelerators is first discussed. The other topics considered are the characteristics, accelerator guides, injection system, radiofrequency system, converter, and positron transport optics. (J.S.R.)

4363 (LNF-63/53) IMPIANTO A RADIOFREQUENZA PER IL PROGETTO ADONE 1500 Mev. (Radiofrequency Plant for the 1500 Mev Adone Project). Note No. 209. D. Fabiani, A. Massarotti, M. Puglisi, and F. Tazzioli (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 31, 1963. 27p.

The characteristics and theory of the radiofrequency installation for the ADONE accelerator project are discussed. A block diagram gives the components of the system, and the circuits and characteristics of each component are described in some detail. (J.S.R.)

4364 (LNF-63/55) TEORIA LINEARE DELLE MACCHINE ACCELERATRICI. PARTE III. CALCOLO DEI COEFFICIENTI DI ACCOPPIAMENTO TRA LE OSCILLAZIONI ORIZZONTALI DI SINCROTRONE E DI BETATRONE. INFLUENZA DELLE FLUTTUAZIONI DELL'IRRAGGIAMENTO SULLE DIMENSIONI DEL FASCIO. (Linear Theory of Accelerators. III. Calculation of the Coupling Coefficient Between the Synchrotron and Betatron Horizontal Oscillations. Effect of Fluctuations of Irradiations on the Beam Dimensions). Note No. 210. G. Sacerdoti and F. Uccelli (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 5, 1963. 5p.

A procedure is indicated for the calculation of the coupling constants between the betatron and synchrotron oscillations. The effect that the statistical fluctuations of the irradiations have on the horizontal dimensions of the beam is examined. (tr-auth)

4365 (NP-13345) ETUDE DES OSCILLATIONS SYNCHROTRONIQUES DANS UN SYNCHROTON À GRADIENT ALTERNE. APPLICATIONS À LA MODIFICATION DES CARACTÉRISTIQUES DU FAISCAEU (theses). (Study of Synchrotron Oscillations in an Alternating-Gradient Synchrotron. Applications to the Modification of Beam Characteristics (thesis)). André Chabert (Lyon. Université). [nd]. 103p.

After a review of the theoretical studies previously made on synchrotron oscillations, the effect of random oscillations on the stability of these oscillations is analyzed. The results obtained with an electronic analogue especially designed for the study of synchrotron oscillations are given. An attempt was made to resolve various problems in the utilization of a proton synchrotron connected with synchrotron oscillations. The three problems studied are fixed-frequency acceleration at the end of an acceleration cycle, the reduction of the length of particle bundles delivered by the accelerator, and the simultaneous stability of two beams during the magnetic-field plateau following the acceleration cycle. The characteristics of the electronic analog used are given in an index. (J.S.R.)

4366 (NP-13325) PROTONNYI SINKHROTRON NA ENERGIYU 500 Gev. (Proton 500 Bev Synchrotron). V. V. Vladimirskii, D. G. Koshkarev, and E. K. Tarasov (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki and U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 10p.

Descriptions are given of an injector ring using an auxiliary proton synchrotron (70 Bev) $\frac{1}{7}$ the length of the main accelerator (500 Bev). The 70-Bev accelerator can perform independently and as a 15-Bev injector with a cycle time $\frac{1}{5}$ the nominal. The magnet system has 24 sections with six period rings, each consisting of 44 standard elements of the pair-focusing type and one non-standard section with 4 increased intervals and 5 magnets. The non-standard matrix has an I shape and does not effect the focusing of the other 44. The basic accelerator parameters and the magnet distribution scheme are given. (R.V.J.)

4367 (NP-13353) O PODAVLENII VYNUZHDENNYKH KOLEBANII V KOL'TSEVYKH USKORITELYAKH. (On Depressing Forced Vibration in Annular Accelerators). D. E. Koshkarev and P. R. Zenkevich (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki and U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 10p.

An automatic correction system using a degeneration derivative was suggested for adjusting the center of gravity of a beam in an annular accelerator. The stability of the system was investigated in relation to an arbitrary force, and an analysis was made of the advantages and disadvantages of the system in comparison with previously suggested systems. (R.V.J.)

4368 (PPAD-492E) DESIGN AND OPERATION OF THE PRINCETON-PENNSYLVANIA PROTON SYNCHROTRON. H. L. Allen, G. K. O'Neill, P. J. Reardon, J. Riedel, L. Seidlitz, F. C. Shoemaker, E. P. Tomlinson, and M. G. White (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Aug. 1963. Contract AT(30-1)-2137. 31p. (CONF-114-21)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The 16 sector magnet is weak focusing with n = 0.6 over a useful radial region of 16.5 cm and 6.1 cm vertically. A d-c biased, sine wave excitation at 19 cps is employed, the energy storage being in a resonant capacitor-inductor system. Injection at 3 Mev is provided by an electrostatic generator. Acceleration is achieved by a combination of drift tubes and resonant cavities which must provide 120 kv per turn, and must be precisely tuned over a 12:1 range in frequency. To date, 2×10^{10} protons per pulse have been injected, of which about 10% are captured by the r-f. A method for extracting the proton beam, which is similar to Piccionis' system, but freer of aberrations, is now under design. (auth)

4369 (TID-18191) A BRIEF HISTORY OF VAN DE GRAAFF ACCELERATOR DEVELOPMENT. R. G. Herb (Wisconsin. Univ., Madison). [nd]. Contract AT-11-1-GEN-7. 23p.

The early history and later developments in Van de Graaff generators are discussed. Various insulating means (vacuum, high-pressure gas, etc.) are outlined. (T.F.H.)

4370 (TID-18459) AUTOMATIC LIQUID NITROGEN PUMPING SYSTEM FOR PARTICLE ACCELERATORS. Matti K. Salomaa (Massachusetts Inst. of Tech., Cambridge, Inst. for Nuclear Science). Apr. 16, 1963. Contract AT(30-1)-2098. 14p.

A description is given of an automatic liquid nitrogen pumping system. Pumping of liquid nitrogen into cooling traps up to a predetermined level is achieved by an automatically controlled compressed air system. An important feature of the equipment is the ability to switch automatically from an empty liquid nitrogen reservoir to a full one. This allows for a much more flexible operation than in

conventional systems where the reservoir has to be replaced manually when empty. (auth)

4371 (UCRL-6794) EFFECT OF BETATRON OSCILLATIONS ON THE LONGITUDINAL STABILITY OF A COASTING BEAM. V. Kelvin Neil (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 12, 1963. Contract W-7405-eng-48. 13p.

The stabilizing effect of radial betatron oscillations with regard to longitudinal bunching of an accelerator beam is investigated. A spread in particle circulation frequency arises from a spread in betatron oscillation amplitude. It is shown that this frequency spread is always sufficient to prevent bunching when the beam is coasting at the transition energy. At other energies a spread in canonical angular momentum also results in a frequency spread. A criterion is developed that places a lower limit on the sum of the squares of these two frequency spreads necessary for stability above the transition energy. (auth)

4372 (UCRL-11044) CYCLOTRON ORBITS: A 709 RAY-TRACE PROGRAM FOR CYLINDRICALLY SYMMETRIC MAGNETIC FIELDS. Joe Good, Morris Pripstein, and Howard S. Goldberg (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 3, 1963. Contract W-7405-eng-48. 20p.

CYCLOTRON ORBITS is a 709 program for tracing secondary beams out of a cylindrically symmetric magnetic field. Development of a 6-by-6 transfer matrix allows one to couple to external quadrupole and bending magnets. (auth)

4373 (NP-tr-1071) POLARISED-NUCLEUS SOURCES FOR ACCELERATORS. B. P. Ad'yasevich, S. T. Belyaev, E. K. Zavoiskii, and Yu. P. Polunin. Translated by J. B. Sykes (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Tr. Vses. Konf. po Yadern. Reaktsiyam pri Malykh i Srednikh Energ., Moscow, 1958. 14p. (Handwritten MS. copy).

Concepts for polarized-particle sources are outlined. It is shown that in low-energy cyclic and linear accelerators, no depolarization of the particle beam should occur, whereas in high-energy weak-focusing and strong-focusing accelerators, partial and complete depolarization (respectively) should be observed. (T.F.H.)

4374 THE EFFECT OF THE SPACE CHARGE ON THE FREQUENCY OF THE FREE OSCILLATIONS OF THE PARTICLES IN AN ISOCHRONOUS CYCLOTRON. A. A. Glazov, V. P. Dzhelepov, V. P. Zamolodchikov, V. V. Kol'ga, A. A. Kropin, L. M. Onishchenko, and E. Shvabe. At. Energ. (USSR), 15: 205-9(Sept. 1963). (In Russian)

If the particle beam intensity is increased, the charge-density effects of the circulating beam of the accelerator become more important. In order to gain additional information on this correlation, the dependence of the frequency of the free axial oscillations on the spatial charge density was measured on molecular hydrogen particles accelerated up to 12 Mev in an accelerator possessing a spiral-shaped magnetic field. As the isochronous cyclotron, provided with a spatially variable magnetic field, has a maximum current of 20 to 30 μa, it allows an experimental study of the effect of the space charge. The axial oscillation frequency was measured by determining the resonance excitation of the free oscillations due to the external field. A Ta target was used for the measurements. The effect of the space charge on the free oscillation frequency was found to exceed by a factor of 2 to 3 the mean square error in the resonance frequency measurements. An increased effect was noted at small radii; this is probably due to the small azimuthal expansion of the particle bunch and to the decrease of the vertical oscillation frequency. The space charge also causes a shift of the zone of the resonance interactions. The experimental results were found to agree well with the theoretical predictions. (TTT)

4375 ZGS PROVIDES NEW PATH TO PARTICLE UNDERSTANDING. Atomics, 16: No. 6, 57-60(Nov.-Dec. 1963).

When the Zero Gradient Synchrotron (ZGS) at Argonne National Laboratories reached its design energy of 12.5 Bev in September, physicists were provided with a new tool for exploring the subatomic world. Never before has there been available a high energy machine that accelerates so intense a beam of protons or produces so many particles. The ZGS, a weak focusing machine, is actually a combination of particle accelerators that speed protons to velocities approaching the speed of light. Ionized hydrogen atoms accelerated to 50 Mev by an injector system consisting of a 750-kev d-c supply and a 50-Mev linear accelerator, both pulsed, are fed into the doughnut of the synchotron. Entering when the magnetic field reaches a value of 472 gauss, the protons are sped around the doughnut 1.5 million circuits before they reach 12.5 Bev. The injection process lasts for approximately 200 microseconds. Circulating particles can either be directed to a target to produce mesons or be sent into an extraction system to emerge as an external beam. Thus many experiments may be conducted simultaneously. Experiments planned for the ZGS are enumerated. (H.M.G.)

4376 THE UNIVERSITY OF BIRMINGHAM RADIAL RIDGE CYCLOTRON. W. B. Powell. Atomkernenergie, 8: 374-5(Oct. 1963).

An isochronous-cyclotron yielding 12-Mev deuterons, 24-Mev α particles, and 32-Mev He^3 particles is described with special emphasis on intense He^3 beams and on polarized deuterons. It is primarily intended for nuclear physics experiments in the low-energy range, with intensive He^3 flows and polarized deuterons. (auth)

4377 DEPTH-DOSE STUDIES WITH 3-Bev AND 33-Bev PROTON BEAMS. L. F. Phillips, R. J. King, and F. P. Cowan (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 21: No. 12, 55-6; 58(Dec. 1963). (BNL-7351)

Considerations for personnel safety around the proton synchrotrons (3-Bev Cosmatron and 33-Bev AGS) at Brookhaven are discussed. Special considerations for depth-dose buildup in shields, phantoms, and other parts of the accelerators are discussed. (R.E.U.)

4378 CHARACTERISTICS OF 18 Mev BETATRON. Hiroshi Kamogawa, Hisashi Kamei, et al. (Tokyo Sibaura Electric Co., Ltd.). Oyo Buturi, 32: 385-90(June 1963). (In Japanese)

An 18-Mev betatron was developed. Its main characteristics are: energy-6 ~ 18 Mev variable, x-ray output-30r/min at 1 m from the target, electron output-500 rad/min at 50 cm from the exit window, weight power consumption-20 kw, magnet-1,870 kg, cooling-built-in fan, rating-continuous. (auth)

4379 THE 25-Mev ELECTRON LINEAR ACCELERATOR. Hisakazu Hatano, Tsutomu Okada, et al. (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Intern. Ed., 18: 576-82(May 1963). (In Japanese)

An electron linear accelerator capable of producing beams with a maximum energy over 25 Mev is described. Its major features are: the wave pattern in the guides is

$2\pi/3$, instead of $\pi/2$, a tantalum disk heated by electron bombardment is used as the electron source, two traveling-wave tubes (3W20 and 3W80) are used as the microwave oscillator (2,810 Mc) and as the intermediate amplifier, two klystrons (M4614's) with peak power output of 5 Mw each are used for feeding the waveguides. The working ranges are: electron energy-4 to 25 Mev, peak electron beam intensity-250 ma max, electron beam pulse width-0.6 to 5 μs, pulse repetition rate-1 pps to 500, single shot. (auth)

4380 PARTICLE ACCELERATION IN CIRCULARLY POLARIZED ELECTROMAGNETIC FIELDS. Winfried Otto Schumann (Technische Hochschule, Munich). Z. Angew. Phys., 16: 213-14(Oct. 1963). (In German)

Particle acceleration for right- and left-circularly polarized fields with a following magnetic loss component was calculated. (tr-auth)

4381 USKORITEL' ELEKTRONOV NA 680 Mev. (680-Mev Electron Accelerator). Moscow, Gosatomizdat, 1962. 88p.

Eight articles are presented on the characteristics, power supply, electron injection, startup, and uses of a 660-Mev synchrotron with the following parameters: maximum energy 660 Mev, mean annular sector radius 200 cm, injected electron energy 800 kev, injection magnetic field 20 gauss, accelerator field 11,500 gauss, initial accelerating field frequency 18.7 Mc, final field frequency 20.6 Mc, accelerating cycle frequency 0.2 c, and electron intensity per pulse $>10^9$. (R.V.J.)

Astrophysics and Cosmology

4382 (NYO-10517(p.7-15)) Rb–Sr AGE OF STONY METEORITES. W. H. Pinson, Jr., C. C. Schnetzler, E. Beiser, H. W. Fairbairn, and P. M. Hurley (Massachusetts Inst. of Tech., Cambridge).

Stony meteorites analyzed by the Rb–Sr method yielded the following results. The cosmologically determined decay constant for Rb^{87} is 1.40×10^{-11} year^{-1}. The average of the cosmologically, geologically, and physically determined decay constants is 1.42×10^{-11} year^{-1}, and this value for λRb^{87} is proposed as a new value to be used in calculating Rb–Sr ages. For purposes of comparison the Rb–Sr age of the stony meteorites is $4.55 \pm 0.20 \times 10^9$ years, (for $\lambda Rb = 1.38 \times 10^{-11}$ year^{-1}), the stated error being the 95% confidence limit, based on the errors associated with the slope of the least squares plot of the meteorite data isochron. The initial Sr isotopic ratio for Sr^{87}/Sr^{86} is 0.698 ± 0.001. (auth)

4383 (NYO-10517(p.119-20)) RUBIDIUM–STRONTIUM STUDIES OF METEORITE PHASES. R. M. Shields (Massachusetts Inst. of Tech., Cambridge).

Phase separations on the meteorite Bjurbole were carried out by hand picking and by use of a Franz magnetic separator. An attempt, largely unsuccessful, was made to prevent contamination during the chemical separation of Rb and Sr. Sr^{87}/Sr^{86} and Sr^{86}/Sr^{88} ratios were obtained by mass spectrometry for the matrix material between the chondrules of the meteorite. The results give a Rb–Sr age of 2.9×10^9 yr, using a decay constant of 1.42×10^{-11} yr^{-1}. (D.C.W.)

4384 THE FLUORINE CONTENT OF SOME CHRONDRITIC METEORITES. David E. Fisher (Cornell Univ., Ithaca, N. Y.). J. Geophys. Res., 68: 6331-5(Dec. 1, 1963).

The fluorine content of four normal chondritic and two carbonaceous chondritic meteorites was determined by nondestructive activation analysis. The range in values is $(0.4 - 4) \times 10^{-4}$ gram/gram. The F^{19}/O^{18} meteoritic ratio is not in agreement with predictions based on the creation of these nuclides in stars. (auth)

4385 THE DYNAMICS OF SPHERICAL STELLAR SYSTEMS. III. THE RELATIVE LOSS OF STARS WITH DIFFERENT MASS. Richard W. Michie (Univ. of California, Berkeley). Monthly Notices Roy. Astron. Soc., 126: 331-41(1963).

A distribution function that includes a velocity-space anisotropy and that satisfies the Boltzmann equation for both large and small energy is used to calculate the relative rate of stellar mass loss from spherical systems. The calculations are based on the velocity-space flux vector, and do not employ the use of a relaxation time. The loss of stars of different mass at varying distances throughout the system from different spherical models demonstrates the dynamical importance of the low-mass stars. The stars with mass $\sim 1/4$ the average stellar mass may leave the system, as a result of distant encounters, from 10 to over 100 times faster than the average stars, depending on the model. The depletion of low luminosity stars in galactic clusters and the distribution of white dwarfs in globular clusters is briefly discussed. (auth)

4386 AN EXPERIMENT TO MEASURE THE MAGNETIC FIELD OF THE GALAXY. I. TECHNIQUES OF MEASUREMENT. R. D. Davies, W. L. H. Shuter, C. H. Slater, G. L. Verschuur, and P. A. T. Wild (Univ. of Manchester, Eng.). Monthly Notices Roy. Astron. Soc., 126: 343-52(1963).

The galactic magnetic field can be measured by investigating the Zeeman splitting of neutral hydrogen spectral features at 21-cm wavelength. Three versions of a basic measurement technique applied to the problem are described and their merits are discussed. Low noise receivers and switches make it possibie to extend the measurement of the Zeeman effect to weaker radio sources and to neutral hydrogen emission regions with narrow line widths. (auth)

4387 AN EXPERIMENT TO MEASURE THE MAGNETIC FIELD OF THE GALAXY. II. RESULTS AND DERIVATION OF MAGNETIC FIELD INTENSITIES. R. D. Davies, W. L. H. Shuter, C. H. Slater, and P. A. T. Wild (Univ. of Manchester, Eng.). Monthly Notices Roy. Astron. Soc., 126: 353-68(1963).

The difference in intensity between right- and left-hand circular polarization was derived as a function of frequency from observations of a number of spectral features. These results were then interpreted in terms of the line-of-sight component of the magnetic field in each feature on the basis of a uniform magnetic field passing through all the clouds that comprise each feature. This latter assumption is justified on the basis of published measurements of the polarization of starlight. Six absorption features in the strong radio sources Cassiopeia A, Cygnus A, Taurus A, and Sagittarius A and one emission feature at Dec. = +10° and R.A. = 4^h20^m were studied. The four deepest features showed no best-fitting line-of-sight component greater than 7×10^{-6} gauss. These four results can be combined to provide a best fit to a circular magnetic field parallel to the spiral arms with a magnitude of $6.8 \pm 3.2 \times 10^{-6}$ gauss directed anticlockwise around the Galaxy. Alternatively, a rather better fit can be obtained to a magnetic field inclined at ~20° to the neutral hydrogen spiral arms with a magnitude of 10×10^{-6} gauss in the same direction. It is concluded that the average

magnetic field in the disk of the Galaxy is $\leq 10 \times 10^{-6}$ gauss. (auth)

4388 AN EXPERIMENT TO MEASURE THE MAGNETIC FIELD OF THE GALAXY. III. DISCUSSION OF THE MAGNETIC FIELD MEASUREMENTS. R. D. Davies and W. L. H. Shuter (Univ. of Manchester, Eng.). Monthly Notices Roy. Astron. Soc., 126: 369-76(1963).

Effects that may possibly make the magnetic field measured in the Zeeman experiment less than that of the general magnetic field in the interstellar medium are discussed. It is shown that the magnetic field inside clouds is unlikely to be much less than that outside the clouds; indeed the cloud field may well be greater than the general field if the clouds have experienced gravitational contraction. Thus on the basis of the present results the general field cannot be $\sim 3 \times 10^{-5}$ gauss as required by some authors. With a general galactic magnetic field of 7×10^{-6} gauss the polarization of starlight can be adequately explained by the Davis-Greenstein theory if the uncertainties of that theory are taken into account. Such a field can also produce the required stabilization of the galactic spiral arm structure. On the other hand the synchrotron radio emission from the disk of the Galaxy would require a general field of $\sim 3 \times 10^{-5}$ gauss, and an alternative picture is proposed in which the emission comes from localized regions of enhanced magnetic field and perhaps also of high cosmic ray electron flux. A field of 7×10^{-6} gauss in the disk and 2×10^{-6} gauss in the halo is insufficient to hold the most energetic cosmic ray particles with energies $\geq 2 \times 10^{18}$ ev in the Galaxy. Fields as high as this are an embarrassment to theories of star formation unless some way is found of effectively removing the charged particles from the contracting cloud. (auth)

4389 THE STRUCTURE OF THE SOLAR ATMOSPHERE IN ACTIVE AND UNDISTURBED REGIONS. IONIZATION OF HYDROGEN AND HELIUM. R. A. Gulyaev, K. I. Nikol'skaya, and G. M. Nikol'skii (Inst. of Terrestrial Magnetism, Ionosphere and the Propagation of Radio Waves, Academy of Sciences, USSR). Soviet Astron.-AJ (English Transl.), 7: 332-41(Nov.-Dec. 1963).

Active and undisturbed regions of the solar atmosphere are discussed. Eclipse observations in Sr II lines in the Balmer continuum are used to determine the distribution of temperature T, the neutral hydrogen density N_{HI}, and the electron density n_e in the lower chromosphere for $h \geq 1000$ km. The results are in good agreement with the model of the transition region and the corona for $h > 5000-7000$ km. Various mechanisms for the ionization of He and H are discussed. The distribution of H I, He I, He II, and He III was found at heights between 1000 km and the inner corona. Short-wave solar radiation is found to play an important role in the ionization of H and He in the chromosphere and in the transition region. Theoretical calculations of the continuous emission of He at $\lambda \leq 504$ Å and 228 Å are in good agreement with rocket data. (auth)

4390 THE K_{2v2} LINE PROFILE AND THE STRUCTURE OF THE SOLAR ATMOSPHERE. V. N. Obridko (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron.-AJ (English Transl.), 7: 342-8(Nov.-Dec. 1963).

The Thomas-Jeffries theory for the source function is applied to a computation of the profile of the Ca II line K_{2v2}. Comparison with the observations shows that the K_2 component originates in a quasi-isothermal region, and K_3 in a region with a sharp temperature rise. The distribution of temperature, electron density, and neutral-hydrogen density with height in the chromosphere is derived for active and undisturbed regions. For a given height, the temperature is somewhat lower in the active regions, with the high-temperature rise setting in at a lower height in the undisturbed regions. (auth)

4391 THE FORMATION OF SUNSPOTS AND SOLAR MAGNETIC FIELDS. [PART] I. P. R. Romanchuk (Kiev Univ. Observatory). Soviet Astron.-AJ (English Transl.), 7: 365-71(Nov.-Dec. 1963).

Arguments are given to show that the magnetic fields of sunspots represent a local intensification of the general solar field. It is suggested that the field of a bipolar spot group (active region) is generated by large-scale convective mass motion in the subphotospheric layers. A system of toroidal fields is formed as each convective element rises and an adjacent region of plasma sinks in the general solar field. The fields arise from inductive currents, and lie in a vertical plane parallel to the solar field and containing the convective element. Upon emerging at the solar surface, the magnetic fields of many convective elements combine to form the field of a bipolar spot group. Their structure agrees with the observations of Stepanov and Bumba, who find that the field of each spot has two polarities. The field strength of the convective elements is estimated. Fields of 10^3 to 10^4 gauss can form if the initial field is 50 gauss and the convective cells (10^9 cm across) ascend at a rate of 10^3-10^4 cm/sec for a period of 10^6-10^7 sec. (auth)

4392 THERMOELECTRIC PHENOMENA ON THE SUN. II. THERMAL CURRENTS IN THE CENTRAL PARTS OF THE SUN. S. M. Shtil'shtein (Inst. of Heat Physics, Academy of Sciences, Siberian SSR). Soviet Astron.-AJ (English Transl.), 7: 372-8(Nov.-Dec. 1963).

The possibility of the appearance of localized magnetic fields on the sun as a result of thermal currents in the solar plasma is considered. Asymmetry of the current system, necessary for the appearance of a nonzero magnetic field, is due to the deviation from spherical symmetry of the temperature distribution. The temperature and current distributions are found for solar plasma with two thermal sources: a continuously acting source at the center of the sun and a short-lived source at some distance from the solar center. The localized magnetic fields originating in this case are estimated. The magnetic field strength is proportional to the intensity of the second source and the time during which it acts. (auth)

4393 INTERACTION BETWEEN SOLAR CORPUSCULAR STREAMS AND COMETARY ATMOSPHERES. II. "COLLAPSING" ENVELOPES. RADIO-FREQUENCY EMISSION. L. S. Marochnik (Inst. of Astrophysics, Academy of Sciences, Tadzhik SSR). Soviet Astron.-AJ (English Transl.), 7: 384-90(Nov.-Dec. 1963).

Envelopes moving in toward the nucleus and collapsing simultaneously to the extended radius vector were observed in explicit form in the comet Morehouse 1908 III. In other comets, such envelopes were observed in the rotation of rays—the terminations of the envelopes—toward the axis of a type I tail. This phenomenon is related in its origin to the presence of a comet head–stream interface. Because of the magnetic field frozen into the stream, the interface plays the role of a rigid wall sweeping the ionized gas of the head into the tail and simultaneously becoming deformed in the process of flowing around a dense-gas region in the center. The envelope becomes visible as a result of emitting ions swept up by the magnetic piston, the inter-

face. The initially solid magnetic wall is later fragmented as a result of channel plasma instability, with rays and streams appearing in the tail. The speed of the piston and the shock wave propagating ahead of it is inversely proportional to the density of the medium. The density drop from the tail axis to the ends therefore sets up an acceleration gradient in the same direction—points further removed from the axis moving more rapidly. Visually, this leads apparently to the familiar collapse of rays towards the extended radius vector (kinematical effect). Another reason for the described displacement of the rays is probably the reflection of plasma from the magnetized ends of the envelope collapsing toward the extended radius vector. Contours of the envelope near the apex should turn out close to a catenary, evidently. Envelopes are generated fairly rapidly one after another in approximately one hour's span. The ionization required for the envelope to appear during that time successfully occurs, apparently, since the lifetime of the parent molecules prior to the formation of CO^+, N_2^+ in the comet head is of the order of $10^{3.5}$ sec. The speeds at which the envelopes move toward the nucleus were of the order of 1–15 km/sec, e.g., in the comet Morehouse 1908 III. As calculations reveal, in a collision with a chromospheric flare, $v_{env} \simeq 13$ km/sec at $n_k/n_s \simeq 500$, where n_k is the ion density in the peripheral regions of the comet head, and n_s is the stream density. If the stream is of facular origin, then at $n_k/n_s \simeq 500$, $v_{env} \simeq 1.8$ km/sec. The density of ions not radiating in the visible spectrum is apparently close, in the peripheral regions of the head, to the density of neutral molecules. The magnetic wall moving toward the nucleus and simultaneously undergoing deformation, and enveloping the nucleus, focuses ions in a region of the order of ~5000 km from the nucleus. The electron concentration there may attain a level $n_e \simeq 3 \times 10^8$ cm^{-3}. Instability may set in at the front of a focusing shock wave and excite plasma oscillations of frequency $\omega = \sqrt{4\pi e^2 n_e/m}$. At $n_e \simeq 3 \times 10^8$ cm^{-3}, $\omega \simeq 27$ Mc—radio emission of this frequency was received from the Arend-Roland 1956 h comet. The transformation of plasma oscillations to radio-frequency emission may occur as plasma waves are scattered on fluctuations of permittivity ϵ, in the presence of a gradient ϵ, and also in a region where geometric optics does not hold ($\epsilon \simeq 0$). (auth)

4394 THE POSSIBILITY OF APPLICATION OF THE "RADIATING" ELECTRON THEORY TO DESCRIBE THE GENERATION OF γ RADIATION IN CHROMOSPHERIC FLARES. R. É. Guseinov (Shemakhin Astrophysical Observatory, USSR). Soviet Astron.-AJ (English Transl.), 7: 444-6(Nov.-Dec. 1963).

It is assumed that magnetic toroids that on emergence to the solar surface can be lead to chromospheric flares, can accelerate relativistic electrons. On this assumption, the theory of the radiating electron is used to calculate the concentration of relativistic electrons necessary to give the observed γ-ray flux at the earth's surface. If the linear dimensions of the region of such electrons are ~10^7 cm and H ~ 500 G, the concentration should be ~10^2 cm^{-3} for electron energies 10^{10} ev and ~10^4 cm^{-3} for 10^9 ev. (auth)

4395 CENTIMETER-WAVE RADIO AND X-RAY EMISSION FROM THE SUN. M. R. Kundu (Univ. of Michigan, Ann Arbor). Space Sci. Rev., 2: 438-69(Sept. 1963).

Solar radio emission on centimeter wavelengths is found to be very closely associated with solar x radiation during both quiet and disturbed periods. The brightness distributions of the sun on radio and x-ray wavelengths appear to be qualitatively similar. The strong correlation existing between x and r-f emission on wavelengths shorter than about 30 cm and the absence of any correlation on longer wavelengths suggest that x rays originate in the same levels of the solar atmosphere as the emission of centimeter wavelengths. Both the quiet and slowly varying radio and x-ray emissions can be explained by thermal bremsstrahlung mechanisms. (C.E.S.)

Atomic Physics

4396 (D1-82-0302) APPLICATION OF VARIANCE MINIMIZATION TO THE CALCULATION OF ELECTRON ENERGIES. Charles M. Carlson (Boeing Scientific Research Labs., Seattle). Sept. 1963. 29p.

Three general types of approaches are outlined for calculating electronic energies in atoms and molecules. Each of these methods is based upon the same type of procedure, which forms the basis for a local energy method. The first step in the procedure is the derivation of an approximate expression for the energy, which, when varied in a particular manner, exhibits a variance from the mean. The variance is minimized with respect to the adjustable parameters in the wave function and the values of these parameters corresponding to the minimum are substituted back into the expression for the mean energy to obtain the optimum value of the energy. The particular form of expression derived for the approximate energy and the manner in which it is varied to derive the expression for the variance distinguishes each of the three types of approaches from one another. For the last two approaches it is discussed how summation over a finite number of points as opposed to integration may be employed without loss of generality. Finally, specific approaches are suggested, which will not encounter computational difficulties and are likely to exhibit optimum convergence properties. (auth)

4397 (NP-13327) A NANOSECOND TIME-ANALYSER AND A THREE-PHOTON ANNIHILATION DETECTOR FOR THE STUDY OF POSITRONIUM. J. Bell, G. J. Celitans, J. H. Green, J. W. Lee, and S. J. Tao (New South Wales, Australia, Univ., Kensington). 1963. 25p.

Apparatus for the study of positronium formation and decay in gases is described. Two principal methods are adopted: the triple-coincidence scintillation counter detection of annihilation from ortho-positronium and the time-to-pulse-height converter principle for the measurement of positron lifetimes in the nanosecond region. The calibration and performance of the system is reported. Lifetimes and triple-coincidence results for various substances are given. (auth)

4398 (NP-13329) FORMATION AND QUENCHING OF POSITRONIUM IN GASES. 1. RESULTS OBTAINED WITH THE THREE-PHOTON COINCIDENCE METHOD. G. J. Celitans and J. H. Green (New South Wales, Australia. Univ., Kensington). [1963]. 24p.

The three-photon coincidence method is used to study ortho-positronium formation and quenching in argon, nitrogen, oxygen, and mixtures of these gases. Quenching rates are found to be proportional to pressure for all gases and gas mixtures except commercial grade argon. Oxygen–argon mixtures showed a 20% increase in positronium formation for oxygen concentration of the order of 10 parts per million. An increase of about 50% in the formation fraction is obtained for nitrogen–argon mixtures, for nitrogen concentrations of about 10%. A uniform quenching rate is found for oxygen–argon mixtures containing up to

0.1% oxygen, and for nitrogen–argon mixtures containing up to 10% nitrogen. (auth)

4399 (NP-13330) FORMATION AND QUENCHING OF POSITRONIUM IN GASES. PAPER 11. RESULTS OBTAINED WITH THE POSITRON LIFETIME METHOD. G. J. Celitans, S. J. Tao, and J. H. Green (New South Wales, Australia. Univ., Kensington). [1963]. 23p.

The positron lifetime method is used to study ortho-positronium formation and quenching in argon, nitrogen, oxygen, and mixtures of these gases. Quenching rates are found to be proportional to pressure for all gases and gas mixtures, except commercial grade argon. Highly quenched ortho-positronium lifetimes are observed in pure argon, and the formation fraction of positronium is estimated as 0.40 ± 0.04. The quenching rate in oxygen is found to be $(2.3 \pm 0.3) \times 10^7$ sec^{-1} atm^{-1}. This rate holds for oxygen concentration greater than 2% in oxygen-argon mixtures. A constant quenching rate, $(2.51 \pm 0.05) \times 10^8$ sec^{-1} atm.$^{-1}$ is obtained for lower oxygen concentrations: this rate is not significantly different from the quenching rate, $(2.42 \pm 0.07) \times 10^8$ sec^{-1} atm.$^{-1}$, obtained for nitrogen-argon mixtures containing less than 10% nitrogen. Corresponding results obtained with the three-photon coincidence method are also presented. (auth)

4400 (NP-13341) FINE STRUCTURE IN THE DELAYED COINCIDENCE LIFETIME CURVES FOR POSITRONS IN ARGON. S. J. Tao, J. Bell, and J. H. Green (New South Wales, Australia. Univ., Kensington). [1963]. 28p.

A time-to-amplitude converter with a resolution of 1.0 nsec is used to measure the decay of positrons in Ar, O_2, N_2, and Ar–O_2, and Ar–N_2 mixtures. It is found that the decay curve consists of a prompt peak, followed by a "shoulder" and a slow exponential decay. The exponential decay consists of two components. The faster component is attributed to the decay of "free" poistrons having low energies, and the slower component is attributed to the decay of ortho-positronium. The prompt peak is attributed to the decays of para-positronium, excited positronium, and metastable collision complexes. The time constants are 10 to 20 nsec and 80 to 120 nsec for the fast and slow exponential components, respectively. The prompt peak decays much more rapidly than these two. (T.F.H.)

4401 (UCRL-7493) THE COEFFICIENTS CONNECTING THE STARK AND FIELD-FREE WAVE FUNCTIONS FOR HYDROGEN: THEORY AND APPLICATION TO LORENTZ DISSOCIATION. C. Bruce Tarter (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 5, 1963. 41p.

A general expression for the expansion coefficients connecting the Stark (parabolic coordinates) and field-free (spherical coordinates) wave functions for hydrogen is obtained. Numerical tables of these coefficients through principal quantum number $n = 10$ are given. In the course of the derivation several new identities involving generalized hypergeometric functions are deduced. Applications to radiative attenuation, particularly in connection with the ALICE experiment, are discussed. It is concluded that previous calculations have considerably underestimated the degree of radiative attenuation experienced by the ALICE beam, thus decreasing the amount of Lorentz dissociation expected in the plasma region. (auth)

4402 MOTION AND STABILITY OF VORTICES IN A FINITE CHANNEL: APPLICATION TO LIQUID HELIUM II. E. S. Raja Gopal (Oxford Univ.). Ann. Phys. (N. Y.), 25: 196-220(Nov. 1963).

The motion of a vortex ring in a coaxial cylindrical cavity, the motion of a vortex pair in a finite channel, the stability of a vortex near a plane wall, and the application of these results to the critical velocities of liquid helium II are analyzed. In discussing the vortex ring a new representation for the stream function in terms of the modified Bessel functions is given, and this is shown to be equivalent to the usual representations. The new representation enables one to solve for the effect of the boundary. The exact results are suitably approximated when the radius r_0 of the ring is very small or almost the same as the radius R of the cavity. The kinetic energy T increases with r_0 at first, reaches a maximum when r_0/R is nearly 0.9 and then falls rapidly to a small finite value when the vortex touches the wall. The translational velocity V decreases as r_0 increases, becomes zero at $r_0/R \sim 0.9$ and then increases in the opposite direction. The two-dimensional case of the vortex pair in a finite channel shows very similar features, and in the limit of the vortex touching the wall the two cases become identical. The straight vortex near a plane wall is shown to be unstable for disturbances along its length under certain conditions. The use of the correct limiting value of the kinetic energy and the usual impulse of the vortex ring in the Landau criterion for the destruction of superflow leads to $v_{s,c}\, D = (h/2\pi m)(2\ln 2 + \frac{1}{2})$; $D = 2R$. But the momentum of the vortex ring is not a clearly defined concept and so the Landau criterion is formulated as $v_c \geq |T/(\partial T/\partial V)|_{min}$. The results are then nearly the same as the crude Feynman relation $v_{s,c}\, D = (h/2\pi m) \times 2\ln(D/2a)$ on account of an approximate cancellation of the effect of the boundary on the energy and the momentum of the excitation. It is concluded from the analysis of the experimental observations that the suggested mechanisms give an order of magnitude estimate of the critical velocities, but are incomplete in some respects. (auth)

4403 TIME-DEPENDENT VARIATION-PERTURBATION METHOD FOR MANY-ELECTRON SYSTEMS. M. Karplus and H. J. Kolker (Columbia Univ., New York). J. Chem. Phys., 39: 2997-3000(Dec. 1, 1963).

The variation-perturbation method for time-dependent problems was applied to many-electron systems. Specific formulas were developed for the steady-state dipolar interaction between an oscillating electric field and an atom or molecule whose wavefunction is approximated by a Hartree-Fock determinant. The method is illustrated by a number of calculations for the helium atom. Theoretical expressions for the dynamic polarizability, refractive index, and Verdet constant (Faraday effect) were obtained. Comparison with the available measurements shows good agreement between the experimental and the theoretical values. (auth)

4404 600-Å BAND OF HELIUM. Y. Tanaka and K. Yoshino (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chem. Phys., 39: 3081-7(Dec. 1, 1963).

Using the third-order spectrum of a 3-m grazing incidence-type vacuum spectrograph, the 600-Å band of helium was studied in combination with an uncondensed discharge of helium operated at liquid-nitrogen temperature as well as at room temperature. The 600-Å band is tentatively explained as originating in the transition, $A\ ^1\Sigma_u^+ - X\ ^1\Sigma_g^+$ of He_2, where the A state has a potential maximum and the molecule is formed at high vibration levels of the A state by a collision of two atoms, one normal ($1s^2\ ^1S_0$) and one metastable state ($1s2s\ ^1S_0$), through the potential barrier. The observed intensity enhancement of the neon line at 600.04 Å is also discussed with relation to the 600-Å band. (auth)

4405 REMOVAL OF ELECTRON-ELECTRON POLES FROM MANY-ELECTRON HAMILTONIANS. Joseph O. Hirschfelder (Univ. of Wisconsin, Madison). J. Chem. Phys., 39: 3145-6(Dec. 1, 1963).

In many-electron problems, the Hamiltonian has poles $1/r_{ij}$ that produce difficulties in the solution of the Schrödinger equation $H\phi = E\phi$. If ϕ is taken to be $\phi\chi$ where $\phi = \prod_{i>j}[1 + \frac{1}{2}r_{ij}\exp(-\alpha r_{ij})]$, it is found that χ satisfies the new Schrödinger equation $H'\chi = E\chi$ where the new Hamiltonian H' has no electron-electron poles. (auth)

4406 WAVELENGTH OF Hg^{198} ZEEMAN FILTER RELATIVE TO THAT OF THE 2537-Å ABSORPTION LINE OF AN ATOMIC BEAM. Walter G. Schweitzer, Jr., and Karl G. Kessler (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 53: 1382-8(Dec. 1963).

A precise comparison of the wavelength passed by a Hg^{198} Zeeman filter with that of the 2537-Å absorption line of an atomic beam was made. This was done by passing the light from the filter through the atomic beam and then comparing the amplitudes of the two peaks in the resulting reversed lines. A calibration was obtained by measuring the ratio of peak amplitudes with the beam tilted at various angles to the optic axis so as to introduce known Doppler shifts. The wavelengths of the Zeeman filter and atomic beam are shown to be equal to about one part in 10^9. (auth)

4407 OSCILLATOR STRENGTHS FOR LITHIUM AND OTHER THREE-ELECTRON SYSTEMS. M. R. Flannery and A. L. Stewart (Queen's Univ., Belfast). Monthly Notices Roy. Astron. Soc., 126: 387-92(1963).

Analytical wave functions of the open shell type were computed for the $1s^2np\ ^2P$, n = 2, 3, 4, states of the three-electron systems and oscillator strengths for the 2s, 3s, 4s–2p, 3p, 4p transitions in Li I, Be II, ..., F VII were calculated using the dipole length and dipole velocity formulas. Satisfactory agreement is in general obtained with the values determined by the method of Bates & Damgaard (1949). (auth)

4408 NON-FREE PARAMAGNETIC RARE EARTH IONS WITH AN ODD NUMBER OF ELECTRONS IN AN EXTERNAL MAGNETIC FIELD. N. V. Afans'eva. Opt. Spectry. (USSR) (English Transl.), 15: 80-3(Aug. 1963).

Cases of C_{3h} and C_{3v} symmetry were considered. Matrix elements of the crystalline field potential were calculated with account taken of the interaction of the states in the presence of an external magnetic field. The coefficients of the spin Hamiltonian were found for ions with half-integral values of J. The energy levels involved in paramagnetic resonance studies were also determined. (auth)

4409 ABSORPTION AND DISPERSION OF LIGHT IN THE $EuCl_3 \cdot 6H_2O$ CRYSTAL AT THE $^7F_0 - {}^5D_0$ TRANSITION. N. K. Bel'skii. Opt. Spectry. (USSR) (English Transl.), 15: 131-3(Aug. 1963).

Measured absorption and dispersion curves of the 17,258.80-cm^{-1} line of the $EuCl_3 \cdot 6H_2O$ crystal were found to be close to those of Lorentz. Oscillator strength was computed from the absorption and dispersion curves. The line contour was determined mainly by the weak interaction of the electronic transition with vibration of the crystal lattice. (auth)

4410 SHORT-RANGE FORCES BETWEEN ATOMS. W. R. Hindmarsh (Univ. of Newcastle upon Tyne, Eng.). Phys. Letters, 7: 115-16(Nov. 1, 1963).

An empirical method is sought for estimating the order of magnitude of C_{12}, which appears in the Lennard-Jones (12,6) potential energy between two atoms. Experimental values for interactions of like rare gas atoms, of rare gas and alkali metal atoms, and of an excited state of calcium and rare gas atoms were assembled. An equation is obtained with only two adjustable parameters. (R.E.U.)

4411 ON THE HYDRODYNAMICS OF A WEAKLY INTERACTING FERMI GAS. P. Résibois and R. Dagonnier (Université Libre, Brussels). Physica, 29: 1057-78(Oct. 1963).

A general transport equation is derived for weakly interacting fermions whatever the characteristic length of the hydrodynamical inhomogeneity. This covers a wide range of phenomena including macroscopic transport processes and zero sound. An essential role in the derivation of this equation is played by the use of the (ν,N) representation introduced previously. The main advantage of this representation is the ease with which the relevant processes in the dynamics of the system may be selected. It should also be noted that this representation permits to formulate in a simple way the influence of localization energy and momentum on the conservation laws. It is for example shown that the attenuation of zero sound at high frequencies can be understood in terms of ordinary two particle interaction provided the finite duration of the collision and the localization effects are correctly taken into account. (auth)

Cosmic Radiation

4412 (ASD-TDR-62-606) A SUMMARY OF NATURAL PARTICULATE RADIATION IN SPACE. M. C. Chapman and M. R. Morrison (Northrop Corp. Northrop Space Labs., Hawthorne, Calif.). May 1962. Contract AF33(657)-7851. 106p. (AD-400564)

The natural radiative environment in space is studied. The environments considered are the particulate components of the Van Allen zones, solar flares, solar wind, and galactic cosmic rays. The dynamics of these environments are outlined, and intensities and energies specified. The radiation exposure is studied for four representative mission profiles: a 2000-mile equatorial orbit, a 21,500-mile equatorial orbit, an elliptical orbit, and a lunar probe. The intensities and flux-energy spectra are specified, and the limitations and errors involved were discussed. (auth)

4413 (UCRL-7551) COSMIC RAYS FROM LARGE SUPERNOVAE. S. A. Colgate and R. H. White (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 21, 1963. Contract W-7405-eng-48. 22p. (CONF-320-1)

From International Conference on Cosmic Rays, Jaipur, India, Dec. 1963.

The mechanism of type II supernova explosions is followed with a hydrodynamic computing code, from the time of gravitational collapse to reversal of the core velocity owing to the equation of state derivable from the nucleon hard-core potential. The inverse-beta-decay neutrino flux cools the core during implosion, but the partial deposition in the stellar envelope of this flux, plus that from the reflected shock wave, assures sufficient energy to eject 80% of the mass of the star. The resulting shock wave is strong enough so that in the density gradient of the envelope it ejects matter at ≥1 Bev for $\rho \leq 10^4$ g/cm^3. The resulting ejection energy spectrum is calculated. It is in qualitative agreement with observations. The total energy is 10^{51} ergs, and the material in the region of 1 Bev should partially undergo nuclear synthesis up to the ion group. The upper energy limit of the shock acceleration becomes 3×10^{16} ev for a radiation shock and 2×10^{19} ev for a plasma oscillation shock. (auth)

4414 THE μ MESON CONTENT IN A PHOTON-ELECTRON CASCADE INITIATED BY A PRIMARY PHOTON OF ENERGY 10^{15} ev. Szczepan Karakula and Jerzy Wdowczyk (Univ. of Lodz, Poland). Acta Phys. Polon., 24: 231-42(Aug. 1963).

The longitudinal development of a meson cascade in an EAS initiated by a photon of 10^{15} ev is analysed using Landau's equation in approximation A and the total number of mesons created is estimated. On the assumptions concerning the multiplicity of photoproduction, multiple production in π-nucleus collisions and photoproduction cross section, the number of muons in a cascade should vary in the 1300–1800 range. This means that the number of penetrating particles in a photon-initiated shower includes from 3 to 5% of that in a shower of the same size but initiated by a nuclear active particle. (auth)

4415 RADIATION MEASUREMENTS WITH HIGH-ALTITUDE BALLOON FLIGHTS. Rudolf A. Hoffman. Aerospace Med., 34: 427-9(May 1963).

Measurements are reported from a series of high-altitude balloon flights made to obtain additional information about the ionizing space radiations resulting from solar flares. The detection system consisted of a particle telescope for proton and α detection and 2 neutron detectors. Exposure to balloon altitudes was made in Northern Minnesota on 18, 20, and 28 July 1961. A summary of solar flare activity during this period of time is tabulated. A gain shift in the counters occurred that seriously affected the time for which reliable data could be obtained, and made the proton data almost completely unreliable. The count rates for flights 1 and 2 were similar (both flights were made when radiation levels at the altitudes attained were near normal). The count rates for flight 1, made during increased radiation levels resulting from the flare of 15 July 1961, are considerable higher than those obtained during the other flights. The intensity of neutrons reached its highest point at ~60,000 ft on all three flights, although the count rate was highest on the flight made during the period of increased solar activity. Most significant was the difference observed between the neutron spectrum during increased solar activity and the spectrum obtained during quiet conditions. This difference was shown by the ratio of the counting rates in two neutron counters. The ratios observed for flights 2 and 3 were very similar, while the ratio obtained from flight 1 under increased radiation levels was significantly higher. This increased ratio for flight 1 indicates that during solar activity the neutron energy spectrum in the atmosphere hardens; i.e., the spectrum contains relatively more high-energy than low-energy neutrons as compared with the spectrum on a normal day. It is concluded that the neutron measurements give indirect evidence of the intensity of solar flare protons present. (BBB)

4416 ON COSMIC RAY CUTOFFS. Herbert H. Sauer (State Univ. of Iowa, Iowa City) and Ernest C. Ray. Ann. Phys. (N. Y.), 25: 135-42(Nov. 1963).

A cosmic ray cutoff in the Størmer sense is defined for sufficiently high latitudes when the magnetic field, while not axially symmetric, becomes approximately so at sufficiently great distances from the earth. It is shown that the cutoff, when so defined, is given by a simple function of McIlwain's L parameter. Numerical comparisons are made with a previous computer study of cutoffs defined in the same way. The expression for cutoff in terms of L suggests that the cutoff in the direction of the magnetic field should be approximately constant along a line of force. This is shown numerically to be so at latitudes too low for the derivation of the L expression to hold, for a particular field model. (auth)

4417 ON THE ROLE OF SOLAR COSMIC RADIATION IN FORMING ELECTRON COMPONENTS IN RADIATIVE EARTH ZONES. A. I. Ershkovich (Inst. of Atmosphere Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 10, 1601-3(Oct. 1963). (In Russian)

Previously it was shown that a considerable part of the electrons captured by the geomagnetic field comes from galactic neutron β decay. An attempt was made to show that during years of maximum solar activity, electrons originate from solar cosmic rays. Considering that neutrons are produced in the atmosphere with Maxwell temperatures $\theta \approx 4$ Mev, then $S(E) = E\,\theta^{-2}\,e^{E/\theta}$. The solar proton energy is $\lesssim$100 Mev. The proton path in nitrogen is less than the mean free path l(E) of 1-Mev neutrons. Consequently, in contrast to galactic neutrons, most neutrons are produced near the earth's atmosphere, do not have time to slow down, and have almost an original spectrum. (R.V.J.)

4418 ELECTRON DENSITY PROFILES IN THE LOWER IONOSPHERE DUE TO SOLAR COSMIC RAYS. W. R. Webber and P. S. Freier (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 68: 6223-8(Dec. 1, 1963).

The ionospheric electron density profiles measured by multiple frequency radio absorption technique are compared with those profiles deduced from particle measurements at balloon altitudes. The electron densities predicted on the basis of the ionospheric parameters and exponential rigidity spectrums of Freier and Webber agree well with the measured profiles. The use of Kane's revised values for the collision frequency along with the predicted electron densities give absorptions somewhat smaller than measured values for some solar events. The contribution of solar α particles to the electron densities should be included to resolve the discrepancy. (auth)

4419 THE FRAGMENTATION OF HEAVY COSMIC RAY NUCLEI IN LIGHT ELEMENTS. M. W. Friedlander (Washington Univ., St. Louis), K. A. Neelakantan, S. Tokunaga, G. R. Stevenson, and C. J. Waddington. Phil. Mag. (8), 8: 1691-1712(Oct. 1963).

The interaction and absorption fragmentation parameters and mean free paths of heavy, $Z \geq 3$, cosmic ray nuclei were measured in polyethylene $(CH_2)_n$ and teflon $(CF_2)_n$. Within the statistical accuracy of these results it was shown that previously deduced values of the fragmentation parameters in the atmosphere were essentially correct, as were the mean free paths. Tentative values were deduced for the fragmentation parameters in hydrogen and were compared with those assumed previously. The significance of these results is discussed. (auth)

4420 COSMIC RAYS IN METAGALACTIC SPACE. V. L. Ginzburg and S. I. Syrovatskii (Lebedev Inst. of Physics, Academy of Sciences, USSR). Soviet Astron.-AJ (English Transl.), 7: 357-64(Nov.-Dec. 1963).

On the basis of evolutionary cosmology, the energy density of w_{MG} of cosmic rays in metagalatic space is probably much less than the energy density $w_G \approx 10^{-12}$ erg/cm^3 in the Galaxy. The best estimate at this time is $w_{MG} \approx 10^{-16}$ to 10^{-15} erg/cm^3. The energy density w_R of the thermal radiation in the Metagalaxy is about 10^{-15} erg/cm$^3 \approx 10^{-3}$ ev/cm^3. Models are also discussed for which w_{MG} is comparable with w_G within the local supergalaxy or Local Group only, but these models can only explain the data for

galactic cosmic rays if several far-reaching and improbable assumptions are introduced. On the other hand, the galactic theory for the origin of most of the cosmic rays observed at the earth does not encounter any serious objections. The electron component of cosmic rays, and radio emission and γ radiation of extragalactic origin are discussed. (auth)

4421 SPACE-TIME DISTRIBUTION OF EVENTS. Joseph Andrew McClure, Jr. Thesis, Nashville, Vanderbilt Univ., 1963. 140p.

In connection with a single two-particle interaction, an event density function describing the distribution in space and time of the interaction was deduced. If $\psi(x_1,x_2)$ and $\psi_0(x_1,x_2)$ are respectively the two-particle (two-time) wave function altered and unaltered by the interaction, $\int d^3\chi_1 d^3\chi_2 |\psi - \psi_0|^2$ is taken to measure the amount of interaction that has occurred. Pair production is neglected, and this expression is taken at a common time after the interaction is over. The integral is equal to $\int d^4\chi_1 d^4\chi_2 [-\overline{\psi}_0 V\psi + \text{h.c.}]$ where V is the interaction function. If one set of four-variables can be eliminated by means of an event coordinate or by use of a δ-function interaction, $[\overline{\psi}_0 V\psi + \text{h.c.}] + \partial_\mu A^\mu$ can be interpreted as an event density. A is any four-vector that vanishes in regions of no interaction. The density should be positive definite, but property has not been satisfactorily demonstrated. A computation approximation procedure for the density is developed. An attempt to extend this density to situations involving more than one event indicated that it is not suited to the treatment of multi-event systems. For multi-event systems a description of inter-event relationships in terms of event separtion operators is sought. This employs a two-particle event location defined classically in terms of the incoming and outgoing asymptotic particle world lines. For the incoming pair, a point on each line is determined by finding the points that minimize $\delta S_{12}^2 = (\chi_2 - \chi_1)^2$ subject to the condition that $(\chi_2 - \chi_1)$ is orthogonal to the total four-momentum. Points are similarly defined on each of the outgoing asymptotic lines. In a system of three events where one particle is common to each pair, differences of the points give the event separations. The separations are expressed in terms of a set of canonical coordinates for the three-particle system. By the classical analogy procedure, the coordinates become single-particle operators, and the event separations become event separation operators. Commutators of some of the separation operators are examined. To test the density and multi-event methods, a one-dimensional calculation involving three particles and three events is made. The particles considered are an electron, a neutrino, and an antineutrino; they are represented by wave-packet solutions of the Dirac equation. In the density approach, where an interaction is explicitly involved, a direct, local interaction of the form $B\delta^4(\chi_2 - \chi_1)$ is assumed. Here B is a scalar involving the γ-matrices of the two particles. This is treated in lowest approximation. A similar approximation is made in the multi-event method. In this calculation, the motions and spreads of the particle wave-packets, determined by ordinary quantum-mechanical procedures, are compared with the event quantities found for these three events. It is found that the event locations, separations, and statistical spreads are in good agreement with one another and with intuitive expectations based on the packet behavior. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4422 GEOMAGNETICALLY TRAPPED RADIATION FROM FAST COSMIC-RAY ALBEDO NEUTRONS. Allen M. Lenchek. Thesis, College Park, Md., Univ. of Maryland, 1963. 136p.

The intensity, energy spectrum, and angular distribution of fast albedo neutrons generated by the galactic cosmic radiation were calculated. The angular distribution is peaked in the horizontal direction with an angular width that is inversely proportional to the neutron momentum. The source function of the global component, which results from the albedo distribution, was calculated. It is quite uniform with respect to altitude and pitch angle over the inner belt, varying only very slowly as compared to the variation of loss rates or lifetimes. The latter were studied for the relevant collision processes. For fast protons the only important processes are ionization loss in Coulomb collisions and (at very high energy) absorption in nonelastic nuclear collisions. The lifetimes are therefore governed by the air density integrated over the path of the particle. In order to calculate the integrated air density it is sufficient that the altitude of the mirror traces be determined vs longitude, however these must be mapped in the true (distorted) magnetic field rather than in any dipole representation. This was carried out, yielding angular (spatial) distributions. The fact that the angular distribution of the albedo is energy dependent is shown to affect the energy spectrum of the source function, steepening it significantly. The equilibrium energy spectrum that is then calculated is in good agreement with measured spectra. The dependence upon pitch angle of the equilibrium energy spectrum was investigated. The distribution of trapped protons that result from the impact of solar cosmic rays has also been computed, with results that agree with experiment. We concluded that the fast neutron albedo quantitatively accounts for the trapped protons. High energy albedo neutrons also inject relativistic electrons. The energy spectrum of such electrons is similar to the spectrum measured above 1 Mev in the outer belt. However the predicted intensity is much smaller than that observed. (TCO)

4423 FLUX DENSITY OF PRIMARY HEAVY NUCLEI IN THE COSMIC RADIATION NEAR THE GEOMAGNETIC EQUATOR. Robert Edward McDaniel. Thesis, University Park, N. Mex., New Mexico State Univ., 1963. 67p.

The flux of the heavy nuclei component of the primary cosmic radiation was measured near the geomagnetic equator. A stack composed of 144 Ilford G-5 emulsions each 10 × 15 × 0.06 cm was lofted at a geomagnetic latitude of 4°N by means of a skyhook balloon. It remained at an average altitude of 106500 feet for about six and one-half hours. An analysis was made of the primary cosmic ray nuclei with atomic number (Z) of 6 or greater that traversed the stack. A two-fold criterion of delta ray and blob measurements was used to identify the tracks of the nuclei. The following flux values, Γ, extrapolated to the top of the atmosphere, were determined for VH nuclei (Z ≥ 20), H nuclei (Z ≥ 10), and M nuclei (6 ≤ Z ≤ 9). $\Gamma_{VH} = 0.10 \pm 0.03$, $\Gamma_H = 0.36 \pm 0.05$, and $\Gamma_M = 0.57 \pm 0.08$ (particles m^{-2} s^{-1} sr^{-1}). Experimental conditions and techniques were designed to minimize the experimental errors. The errors determined are lower than those on all previous values reported except one. The possible importance of these results on proposed models of the universe is discussed. (TCO)

Direct Energy Conversion

4424 (AD-299699) INVESTIGATION OF NON-EQUILIBRIUM IONIZATION FOR MHD ENERGY CONVERSION. Quarterly Report No. 4, December 15, 1962 to March 15, 1963. (General Electric Co. Missile and

Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Contract AF33(657)-8298. 9p.

Accomplishments are reported on a theoretical and applied research program directed toward prolonging the lifetime of magnetohydrodynamic (MHD) energy converters by reducing the necessary operating temperatures to the range of 1000 to 2000°K. The process of interest is the use of the self-induced electric field in the MHD generator for electrical break-down of appropriate working fluids of interest. Work is directed toward the use of potassium for Rankine (vapor) cycles, and argon plus cesium for studying the basic parameters of the break-down, although the results are applicable to gas (Brayton) cycles with certain nuclear reactors. (auth)

4425 TOWARDS POWER GENERATION OF MHD. P. R. Howard (Central Electricity Research Labs., Leatherhead, London). New Scientist, 20: 378-80(Nov. 14, 1963).

The basic magnetohydrodynamic generator concept is discussed. Topics covered include: practical problems, gas conductivity, power extraction, "seed" recovery, and the magnet system. Prospects for the future are described. (M.C.G.)

4426 MHD POWER GENERATION: PROMISES AND PROBLEMS. T. C. Tsu and L. S. Frost (Westinghouse Research Labs., Pittsburgh). p.261-9 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The advantages of MHD generators for space vehicles include the fact that MHD is a volume process so that the efficiency increases with the size of the machine, almost any desired voltage-current characteristics can be obtained by changing the dimensions of the duct, and MHD generators can be relatively small and light. Current problems of research are discussed. The plasma must have sufficient electrical conductivity, and both thermal and nonthermal ionization are being studied to solve this problem. The effects of very strong magnetic fields on the MHD process are examined. Real machine effects, i.e., nonuniformity of the magnetic field, end effects, imperfectly conducting electrodes, etc., must be considered now that MHD has come of age. (M.P.G.)

4427 THERMIONIC-NUCLEAR SPACE POWER SYSTEMS. Herman Miller (General Electric Co., Pleasanton, Calif.). p.171-89 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The features of a thermionic-nuclear space power system, which could be used as the power supply for electrical propulsion devices are discussed. Since the really new feature is the thermionic conversion, the bulk of the attention is directed at this portion of the system. How a thermionic device works, the phenomena that must occur for the device to be effective, the phenomena that do occur, and the phenomena that are occurring that are not understood are reviewed. The current status of thermionics, the work that is under way, and possible nuclear thermionic space power systems based on the thermionics technology are also discussed. (auth)

Elementary Particles and Radiations

4428 (BNL-809) MUON BIBLIOGRAPHY. Marjorie Comstock, comp. (Brookhaven National Lab., Upton, N. Y.). Apr. 1963. Contract AT-30-2-GEN-16. 22p.

References relating to μ mesons are presented for 1958 to April 1963 and are arranged according to year. Sources for the 625 references are Nuclear Science Abstracts, Science Abstracts, Series A, Physics, and the Brookhaven Research Library. Subjects included are static properties, electromagnetic interactions, mesic atoms and molecules, weak interactions, μ-meson structure and anomalous interactions, cosmic rays, and μ-meson beams. (R.E.U.)

4429 (CONF-231-3) THE $\Delta I = \frac{1}{2}$ RULE FOR NON-LEPTONIC STRANGENESS-CHANGING DECAY PROCESSES. R. H. Dalitz (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies). [1963]. Contract [AT(11-1)-104]. 33p.

From International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., Sept. 1963.

It is shown that the rule $\Delta I = \frac{1}{2}$ is qualitatively valid for all the non-radiative, non-leptonic, strangeness-changing decay processes of strange particles. The decay processes studied include $K_{\pi 2}$, $K_{\pi 3}$, Λ, Σ, and Ξ decays. (T.F.H.)

4430 (JINR-E-1400) BOUND STATES AND ANALYTIC PROPERTIES IN ANGULAR MOMENTUM. G. Domokos and P. Surani (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 24p.

The Bethe-Salpeter (BS) equation for spinless particles is investigated with a generalized local kernel. Bound states are classified into two classes depending on whether their spin is an analytic function of the mass or not. The solutions of the BS equation depend critically on the behavior of the kernel at high momentum transfers. In any case there exist solutions describing bound states. For strongly singular kernels the scattering amplitude is an analytic function of the angular momentum in the entire complex plane. Regge trajectories are labeled by the representations of the four dimensional rotation group. The positions of the branch points in the angular momentum plane for PS pion-pion interaction are found exactly. (auth)

4431 (LAL-1077) PHOTOPRODUCTION DU MESON η PRES DU SEUIL. (Photoproduction of η Mesons Near the Threshold). B. Delcourt, J. Lefrancois, J. P. Perez y Jorba, and J. K. Walker (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accelerateur Lineaire). Nov. 1963. 83p.

The excitation-curve method is used to measure the differential angular cross section for photoproduction of η^0 mesons on hydrogen at an incident energy of 750 Mev. The threshold energy is 710 Mev. A statistical analysis of the experimental data gives a value of $(d\sigma/d\Omega^*) = 0.83 \pm 0.56$ μbarn/steradian. (T.F.H.)

4432 (TID-19789) AN EXPERIMENTAL STUDY OF CLOSE COLLISIONS OF HIGH ENERGY Mu-MESONS WITH ELECTRONS (thesis). Robert Francis Deery (Washington. Univ., Seattle). Apr. 1960. Contract Nonr 477(12). 99p.

Particles from cosmic-rays were required to pass through 14 in. Pb above and 10 in. Pb below the apparatus. Knock-on electron events originating in a target above the top section of a three-section cloud chamber operating in a field of 11,000 gauss were detected with the aid of two proportional counters, which sandwiched the top section. Electrons and mu mesons were identified by their behavior in traversing Pb plates above and below the middle section. The target was 23.1 g/cm^2 of carbon in one experiment and 17.0 g/cm^2 of paraffin in the other. Energies of the electrons and muons were determined from track curvature measurements, and events accepted only when the electron energy was greater than 100 Mev and the mu energy was

from 5 to 50 Bev. The distribution of electron energies was compared with theoretical predictions based on quantum electrodynamics modified by a one-parameter form factor and corrected for energy loss of the electrons before reaching the chamber. The data taken at face value would suggest an excess of events with large momentum transfers (50 to 100 Mev). The uncertainties inherent in this experiment and poor statistics prevented ascribing too much significance to this excess. (auth)

4433 (UCRL-10977) LOW-ENERGY NEGATIVE PION INTERACTIONS IN DEUTERIUM. William C. Bowman (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 5, 1963. Contract W-7405-eng-48. 82p.

An attempt is made to resolve the discrepancy between the measured deuterium ratio, $S = [\omega(\pi^- + d \rightarrow n + n)/\omega(\pi^- + d \rightarrow n + n + \gamma)]$, and values predicted from the s-wave pion relations and the theoretically calculated ratio $T = [\omega(\pi^- + d \rightarrow n + n + \gamma)/\omega(\pi^- + p \rightarrow n + \gamma)]$. The cross sections $\sigma(\pi^- + d \rightarrow n + n + \gamma) = (3.78 \pm 0.79) \times 10^{-30}$ cm^2/steradian, $\sigma(\pi^- + d \rightarrow n + n) = (3.67 \pm 0.45) \times 10^{-28}$ cm^2/sr, and $\sigma(\pi^- + d \rightarrow \pi^0 + n + n) = (7.84 \pm 0.57) \times 10^{-28}$ cm^2/sr were measured at 90° in the center-of-mass system for 51-Mev incident pion energy. The radiative absorption cross section and the s-wave pion relations indicate the value of $T = 0.91 \pm 0.19$, in agreement with theoretical calculations. The calculation of $S = 1.51 \pm 0.40$ from the cross section measurements and the value $S = 1.92 \pm 0.33$ measured by direction detection of both reactions is in agreement with the value $S = 1.74 \pm 0.26$ calculated from the s-wave pion relations. An indirect measurement comparing radiative captures in hydrogen and deuterium gave a value of $S = 3.37 \pm 0.46$, in relative agreement with other indirect measurements. This discrepancy appears to be due to difficulty in monitoring the number of pions captured in hydrogen and deuterium. A total-absorption plastic scintillation counter was used for all measurements. 49 references. (auth)

4434 (UCRL-11076) ELEMENTARY PARTICLES. Geoffrey F. Chew (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 23, 1963. Contract W-7405-eng-48. 14p. (CONF-351-1)

From Centennial of the National Academy of Sciences, Washington, D. C., Oct. 1963.

Indications that strongly interacting particles are in some sense dynamical structures owing their existence to the same forces through which they mutually interact is noted, and support for a separate theory of strong interactions is cited. The origin of the special symmetries and the associated conservation laws that characterize strong interactions is also discussed. (D.C.W.)

4435 ON COMPLEX ANGULAR MOMENTUM IN MANY-CHANNEL POTENTIAL-SCATTERING PROBLEMS. [PART] III. John M. Charap (Inst. for Advanced Study, Princeton, N. J.) and Euan J. Squires. Ann. Phys. (N. Y.), 25: 143-54(Nov. 1963).

Many-channel potential scattering with arbitrary spin is discussed. A transformation of the Schrödinger equation is introduced that is shown to remove all kinematic singularities in the total angular momentum, so that the transformed S-matrix may be proved to be a meromorphic function of the total angular momentum, the poles being the dynamical Regge poles. It is shown that it is the transformed S-matrix that enters directly into the partial wave expansion of the scattering amplitude in the helicity representation. Unitarity is discussed in terms of the transformed S-matrix. (auth)

4436 DISPERSION THEORY METHODS FOR PION-DEUTERON ELASTIC SCATTERING. [PART] II. J. J. Brehm (Naval Ordnance Lab., Silver Spring, Md. and Univ. of Maryland, College Park). Ann. Phys. (N. Y.), 25: 221-48(Nov. 1963).

The anomalous discontinuities in the l-channel, called for in pion-deuteron elastic scattering, are derived. The methods used start with a choice of the deuteron mass and of the energy such that the discontinuities are given by physical unitarity. Analytic continuation in the deuteron mass leads to the emergence of the anomalous thresholds and provides the formulas for the anomalous discontinuities. The representation of the physical amplitude is obtained by subsequent analytic continuation in the energy. (auth)

4437 MAJORIZATION OF FEYNMAN DIAGRAMS IN WHICH A HEAVY PARTICLE IS CONSERVED. J. B. Boyling (Cavendish Lab., Cambridge, Eng.). Ann. Phys. (N. Y.), 25: 249-68(Nov. 1963).

Feynman diagrams involving baryons and mesons are majorized by a modification of a method due to T. T. Wu. The sets of diagrams required for majorization are given in the cases of four, five, and six external lines. (auth)

4438 FORMULA FOR ANGULAR DISTRIBUTION IN THE STATISTICAL THEORY OF MULTIPLE PARTICLE PRODUCTION. M. Majewski (Univ. of Lodz, Poland). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 535-9(1963).

An expression for the angular distribution formula of the statistical theory of particle production is derived. Its general properties are discussed, and its practical application is considered. (auth)

4439 ANGULAR CORRELATIONS AT THE ANNIHILATION PROCESS $\bar{N} + N \rightarrow \pi + \omega$ AT REST. R. Raczka and J. Werle (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw and Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 549-51 (1963).

The angular correlations at the N-$\bar{N}$ annihilation into four pions in the case in which three pions form an ω resonance of spin 1 and parity -1 are investigated. Correlations are obtained for testing the quantum numbers of this resonance and the conservation laws for its production and decay. (auth)

4440 ANGULAR MOMENTUM WAVE FUNCTION FOR N-PION SYSTEM. R. Raczka (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 553-5(1963).

The wave function for the N-pion system with the definite space parity P is derived for the relativistic case, and the Thrall's projection operator $T_3^{[N_1,N_2,N_3]}$ is used to obtain a wave function for the partition $[N_1,N_2,N_3]$ that is symmetric with respect to simultaneous permutation of charges and space coordinates. (D.C.W.)

4441 ON THE PROBLEM OF DISCRETE QUANTUM NUMBERS FOR THREE PARTICLE STATES. A. Szymacha and J. Werle (Univ. of Warsaw and Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 557-60(1963).

A procedure for finding the discrete quantum numbers that, as previously noted, can replace continuous quantum numbers in a representation for systems of three particles of arbitrary mass and spin values is outlined. (D.C.W.)

4442 EVIDENCE OF FERMI INTERACTIONS WITH CHARGE RETENTION. Philippe Leruste. Compt. Rend., 257: 2252-5(Oct. 14, 1963). (In French)

The term of parity violation in the case of a Fermi interaction, added to the electromagnetic interaction in the scattering of two charged fermions, was calculated. In the Bev region, the corresponding cross section is of the order of 10^4 times less than the pure electromagnetic cross section. (tr-auth)

4443 NOTE CONCERNING THE ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS IN THOMAS–FERMI THEORY. T. Tietz and C. Malinowska (Univ. of Łódź, Poland). J. Chem. Phys., 39: 2778-9(Nov. 15, 1963).

Accurate analytical expressions are given for the scattering length a, the effective range r_0, and the shape-dependent parameter p of low-energy electrons in the Thomas-Fermi theory. (P.C.H.)

4444 ANALYTIC PROPERTIES OF THE S-MATRIX FOR POTENTIAL SCATTERING, RELATIVE TO THE FORCE OF THIS POTENTIAL. R. Nataf and H. Cornille (Institut du Radium, Orsay, France). J. Phys., 24: 591-603(Aug. 1963). (In French)

Analytical properties of the S matrix are obtained with respect to the strength of any potential in the radial Schrodinger equation. Some properties of the analogs of Regge trajectories are derived in the same way, which should give information on the radius of convergence of Born expansion. Enough information is obtained by restricting the study to potentials decreasing faster than an exponential at infinite range. Results are derived for the branches of the trajectories relative to anti-bound states. Restriction to superpositions of Yukawa potentials gives information on some points. In the case of nucleon-nucleon scattering, strengths of both singlet and triplet potentials belong to the same trajectory. As an example, they are calculated in the case of a Yukawa potential from the energies of the deuteron and of the antibound $^1S_0$ state. (auth)

4445 ON RESONANCES IN THE FORMAL THEORY OF SCATTERING. Tamas Dolinszky. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 385-414(1963). (In Hungarian)

In established treatments of nuclear reactions the interaction is assumed to be cut off at a finite distance. An argument is given for treating infinite range interactions in the framework of the formal theory of scattering. Restricted to interactions of the type V(r) an exact many-level dispersion formula is derived. The poles of the scattering matrix are given as roots of a transcendental equation. It is shown that an extrapolation of the poles obtained by cut-off treatment to infinite ranges generally lead to wrong results. It is found that the resonant states do not constitute a complete system in the Hilbert space and do not belong to the subspace where the hamiltonian acts as a Hermitian operator. The compound and the direct contributions to the reaction are defined by the resonant states. Finally, the integral equation for the resonant states is given. (auth)

4446 ELEMENTARY PARTICLES. I. FIRST DISCOVERIES, FROM THE ELECTRON TO THE NEUTRINO. J. M. Lévy-Leblond (CNRS, Orsay, France). Nature (Paris), No. 3337, 185-93(May 1963). (In French)

The history of the discovery of the electron, photon, proton, neutron, positron, and neutrino is outlined. The reasoning leading to the conclusion that no electrons exist inside the nucleus is traced. (T.F.H.)

4447 ELEMENTARY PARTICLES. II. MUONS, MESONS, AND OTHER PARTICLES. J. M. Lévy-Leblond (CNRS, Orsay, France). Nature (Paris), No. 3338, 245-54 (June 1963). (In French)

The discovery and nature of the mesons, muons, and strange particles are outlined. Attention is given to: energy fields and fluctuations; virtual processes; the crossing principle and vacuum polarization; a review of high-energy studies; and resonances. (T.F.H.)

4448 STATISTICAL PROPERTIES OF LIGHT AND THE SUDARSHAN REPRESENTATION. L. Mandel (Imperical Coll. of Science and Tech., London). Phys. Letters, 7: 117-19(Nov. 1, 1963).

It is shown that the diagonal representation of the density operator, which is formed on the basis of the eigenstates of the photon annihilation operator in configuration space, for a canonical ensemble leads to invariance in the Gaussian random process and correspondence between quantum-mechanical and semiclassical descriptions of the electromagnetic field. (R.E.U.)

4449 ON THE UNIVERSAL COUPLING OF THE ρ-MESON. A. Daudin (Laboratoire de Physique Corpusculaire à Haute Energie, Saclay, France); M. A. Jabiol, C. Kochowski, C. Lewin, F. Selleri, S. Mongelli, A. Romano, and P. Waloschek. Phys. Letters, 7: 125-7(Nov. 1, 1963).

A sample of 576 hydrogen bubble chamber events of the reaction $\pi^+ + p \rightarrow \pi^0 + \pi^+ + p$ was analyzed by examining the mass distributions for pairs of particles. A strong peak was found for the system $\pi^+\pi^0$, corresponding to the formation of the T = J = 1 $\pi\pi$ resonance (ρ-particle). The π^0 angular distribution was calculated. It is concluded that isobar production is consistent both with the ρ-exchange model and with the hypothesis of the universal coupling of the ρ-meson to the isospin current. (R.E.U.)

4450 AN SU_3 MODEL OF V-V INTERACTIONS FOR THE MESON RESONANCES OF T = 0. A. N. Mitra and S. Rai Choudhury (Univ. of Delhi). Phys. Letters, 7: 127-30(Nov. 1, 1963).

An SU(3) model of vector particle interactions through the exchange of like particles, and its consequences in the framework of a multichannel Schroedinger-type equation, is presented. The possible V–V states of T = 0, involving different spins, parities, and unitary spins, that appear as bound states in the model are investigated and in particular whether or not the η, ω', and f_0 resonances can be included in this scheme. The V^3-vertex is used for ρ, ω, K^*, and $\overline{K}^*$ interactions. (R.E.U.)

4451 HIGH ENERGY PION-PROTON COLLISIONS WITH LOW MOMENTUM TRANSFER. G. Bellini, M. di Corato, E. Fiorini, A. J. Herz, P. Negri, and S. Ratti (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Phys. Letters, 7: 157-8(Nov. 1, 1963).

The angular distribution in the π-π system for π-mesons at the π-meson vertex of the 2- and 4-prong events was studied at meson(π^-) momenta of 6.1 and 18.1 Bev/c. The invariant-mass distributions of π-meson pairs were studied at the π-meson and proton vertices. The one-π-meson-exchange model is shown to be inadequate for description of the 4-prong π-p collisions. (R.E.U.)

4452 ON THE PRODUCTION OF THE $Z^-(\Omega^-)$ BARYON. H. J. Lipkin (Univ. of Illinois, Urbana and Argonne National Lab., Ill.), C. A. Levinson, and S. Meshkov. Phys. Letters, 7: 159-61(Nov. 1, 1963).

Unitary symmetry is used to relate the production of Z^- to the production of its companion resonances $N^*_\frac{5}{2}$, Y^*_1, and Ξ^*. The production is discussed in proton-antiproton annihilation, K^-p reactions, and photoproduction on protons. Peshkin's symmetry theorem is used to obtain general relations for Z^- production. (R.E.U.)

4453 POLARIZATION IN p-p SCATTERING AT THE PROTON ENERGY OF 8.5 Gev. V. P. Kanavetz (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR), I. I. Levintov, B. V. Morozov, and M. D. Shafranov. Phys. Letters, 7: 165-7(Nov. 1, 1963).

Results are given of polarization measurements in p-p scattering on carbon and lead. The mean value of the polarization of 8.5-Bev protons at $\bar{t} = -0.28$ (Bev/c)^2 (t is 4-momentum transfer squared) is found to be $P = 0.02 \pm 0.06$. (R.E.U.)

4454 RAPID ANNIHILATIONS OF POSITRONS IN POLYATOMIC GASES. D. A. L. Paul and L. Saint-Pierre (Royal Military Coll. of Canada, Kingston, Ont.). Phys. Rev. Letters, 11: 493-6(Dec. 1, 1963).

Experimental values are presented for the annihilation rates in gases of slow positrons that have failed to form positronium. The observed values for argon, methane, ethane, propane, n-butane, isobutane, and carbon tetrachloride are found to exceed the values derived from Dirac theory by factors of 3 to 700. A Na^{22} positron source was used in a cylinder where the sample gases were at up to 10 atm. and a constant (25 ± 5)°C. The effects of molecular electric polarization are discussed. (R.E.U.)

4455 PHOTOPRODUCTION OF CHARGED PIONS FROM BERYLLIUM IN THE Bev RANGE. R. B. Blumenthal (Harvard Univ., Cambridge, Mass.), W. L. Faissler, P. M. Joseph, L. J. Lanzerotti, F. M. Pipkin, D. G. Stairs, J. Ballam, H. DeStaebler, Jr., and A. Odian. Phys. Rev. Letters, 11: 496-9(Dec. 1, 1963).

The peripheral model was used to describe the one-pion-exchange photoproduction at laboratory angles of 1 to 11° at 2 to 6 Bev. Experimental and theoretical photoproduction cross sections are presented. (R.E.U.)

4456 ELASTIC p-p CROSS SECTIONS AT HIGH MOMENTUM TRANSFERS. G. Cocconi (Cornell Univ., Ithaca, N. Y.), V. T. Cocconi, A. D. Krisch, J. Orear, R. Rubinstein, D. B. Scarl, W. F. Baker, E. W. Jenkins, and A. L. Read. Phys. Rev. Letters, 11: 499-503(Dec. 1, 1963).

Eighteen differential cross sections were measured in the energy region 10 to 30 Bev and momentum transfer region $-t = 2.3$ to 19.6 (Bev/c)^2, where $-t$ is the invariant four-momentum transfer squared. The maximum value of $-t$ was 505 f^{-2}, which is an interaction distance of 4.4×10^{-15} cm. The results show that the energy dependence at constant momentum transfer is more pronounced at higher momentum transfer, the cross sections decrease less rapidly with increasing momentum transfer, and the shapes of the observed angular distributions are similar and appear to be almost constant over ~40% of the solid angle. (R.E.U.)

4457 ANTIPROTON AND KAON ELASTIC SCATTERING AT HIGH ENERGIES. K. J. Foley, S. J. Lindenbaum, W. A. Love, S. Ozaki, J. J. Russell, and L. C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 11: 503-6(Dec. 1, 1963).

Measurements were made of differential cross sections for $\bar{p}$-p scattering at 7.2, 8.9, 10.0, and 12.0 Bev/c, for K^+-p at 6.8, 9.8, 12.8, and 14.8 Bev/c, and for K^--p at 7.2 and 9.0 Bev/c. For $\bar{p}$-p the range of four-momentum transfer squared is $0.03 < -t < 0.6$ (Bev/c)^2 and for K^+-p, $0.03 < -t < 1.1$ (Bev/c)^2. There is some evidence that the $\bar{p}$-p system does not exhibit the Regge-pole shrinkage observed in the p-p system, while the behavior of the K^+-p system is consistent with that of p-p. Data on K^--p are not sufficient to draw shrinkage conclusions. (R.E.U.)

4458 DEUTERON PRODUCTION IN pp COLLISIONS. J. Chahoud (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna), G. Russo, and F. Selleri. Phys. Rev. Letters, 11: 506-7(Dec. 1, 1963).

A model for deuteron production is shown to explain the nonappearance of the second and third πN resonances and the correspondence of the c.m. energy of 2.9 Bev in $p + p \rightarrow d + \pi^+$ to the masses of the first and fourth π-meson-nucleon resonances plus a nucleon mass. The reaction is assumed to proceed by the O.P.E. mechanism followed by an interaction in the final state that binds p and n into a deuteron. (R.E.U.)

4459 SEARCH FOR φ-MESON PRODUCTION IN 3.7-Gev/c π^--p COLLISIONS. Y. Y. Lee, W. D. C. Moebs, Jr., B. P. Roe, D. Sinclair, and J. C. Vander Velde (Univ. of Michigan, Ann Arbor). Phys. Rev. Letters, 11: 508-11 (Dec. 1, 1963).

An upper limit of 0.012 is set for the ratio of the rates of $(\pi^- + p \rightarrow \pi^- + p + \phi)/(\pi^- + p \rightarrow \pi^- + p + \omega)$. Data are presented that pertain to this ratio and the processes for ω-production are interpreted for π^- momentum 3.7 Bev/c. It is found that in about 25% of the ω-production reactions, the outgoing π^-p form a N^* (1688 Mev) resonance and that the reaction does not go predominantly through one-pion exchange. (R.E.U.)

4460 ELECTROMAGNETIC FORM FACTOR OF THE NEUTRINOS. J. Bernstein (New York Univ., New York) and T. D. Lee. Phys. Rev. Letters, 11: 512-16(Dec. 1, 1963).

A zero-mass two-component theory for the neutrino and the existence of an intermediate boson $W^\pm$ are assumed. The scalar function, on which the matrix element of the electromagnetic current operator evaluated between states of a single neutrino depends, is calculated. A marked difference is found between the form factors, $f(q^2)$, for ν_e and ν_μ at small q^2 (where q^2 is the difference in the initial and final four-momenta of the neutrino squared). (R.E.U.)

4461 SYMMETRY FROM BOOTSTRAP MECHANISM. Hong-Mo Chan (Inst. for Advanced Study, Princeton, N. J.), Paul C. DeCelles, and J. E. Paton. Phys. Rev. Letters, 11: 521-3(Dec. 1, 1963).

Equations relating the coupling constants of mutually interacting vector mesons are derived from the N/D bootstrap mechanism. Special cases considered are mutual interaction of (ρ^+, ρ^0, ρ^-) bootstrapping (ρ^+, ρ^0, ρ^-), of eight pseudoscalar mesons (π, K, η) bootstrapping eight vector mesons (ρ, K*, ω), and of seven pseudoscalar mesons (π, K) bootstrapping seven vector mesons (ρ, K*). (R.E.U.)

4462 THE NON-CONSERVATION OF PARITY AND MACROSCOPIC ROTATION. I. Yu. Kobzarev and B. Pontekorvo. Usp. Fiz. Nauk, 81: 3-6(Sept. 1963). (In Russian)

Electrons in the process of β decay were found to be longitudinally polarized. The mechanism by which a spin angular momentum of a polarized particle can be converted into macroscopic rotation of a body is considered. A layer of β activity on one end of a cylinder imparts a momentum $M = (1/2)(v/c)(1/2)hN$, where N is the number of electrons absorbed by the cylinder which acquires a rotational energy $E = M^2/2I$, where I is the moment of inertia of the body. The value of E/N is only 10^{-18} ev, but what is the source of the rotational energy? It is shown that the thermal energy of the cylinder is the energy source. If it is assumed that a beam of polarized electrons is completely depolarized, the thermal motion of the atoms of a body is partially converted to an ordered motion with a velocity $v = \Omega r$, where Ω is the angular velocity, and $\Omega = M/I$. The decrease in

entropy on converting thermal energy to rotational energy is $\Delta S = -(E/T) = -(N^2/8IT)$, and change in temperature T is $\sim 10^{-18}$ ev. However, a body with a rotational moment μ has an energy $-\mu\Omega$ associated with the coriolis field about a rotating body. As $T \to 0$ at very small values of Ω, the resulting coriolis field prevents the occurrence of further depolarization. (TTT)

4463 ELECTRON AND POSITRON COLLECTORS. A. I. Alikhanyan, S. A. Kheifets, and S. K. Esin. Usp. Fiz. Nauk, 81: 7-49(Sept. 1963). (In Russian)

It is pointed out that colliding beams of 1.5-Bev electrons will react with an energy equivalent to a 9×10^3-Bev electron striking an electron at rest. The differential cross sections for elastic coulombic scattering of an electron are tabulated for various energies of the incident particle and various scattering angles. The collision of an electron with a positron is neutral for all "charges" (electrical, baryonic, leptonic, and strangeness). The possible reactions and reaction thresholds in Mev are estimated and tabulated. It is possible that unknown particles can be formed in these reactions. The magnetic system of the collector should assure a beam of small dimensions, since the nuclear reactions have a small cross section. The high-frequency generator must be designed to compensate for the energy loss radiated by the moving particle. Various injection systems are discussed. The electrical interaction between an electron bundle and a positron bundle is taken into account. The probability of interaction between electrons and positrons in a colliding beam is presented. Radiation damping effects are taken into account. The loss of particles, the size of the bundle, the effective lifetime of the beam in a collector are estimated. Details of construction are presented for the Stanford, Geneva, and Adone (Italian) collectors. (TTT)

4464 PHOTOPRODUCTION AND SCATTERING OF PI-MESONS. N. F. Nelipa. International Monographs on Advanced Mathematics and Physics Series. Translated from the Russian (Russian Tracts on Advanced Mathematics and Physics. Volume 7). New York, Gordon and Breach Science Publishers, 1963. 107p. $5.00.

Experimental data on the photoproduction and scattering of mesons (π) on nucleons are presented. The photoproduction differential cross section and the relation between the processes of scattering and photoproduction are discussed. The decomposition of a plane photon wave is considered, and an expression for the polarization of neutrons is derived. Tables of Clebsch-Gordon, Racah, and Z-coefficients are included. (C.E.S.)

4465 ELECTROPRODUCTION OF NEUTRAL PIONS FROM DEUTERIUM. Stephen Lawrence Brown. Thesis, Lafayette, Ind., Purdue Univ., 1963. 95p.

The theory of the production of neutral pi mesons by electrons scattered from deuterons is discussed. Only the case wherein the deuteron remains bound in the final state is considered. The analysis corresponds to a physical situation in which the incident and final electron energies are measured, and the angles of the final deuteron and electron relative to the initial electron and to each other are known. Thus the results are given in the form of a differential cross section per unit energy of the electron, per unit solid angle of the electron, and per unit solid angle of the deuteron. The primary assumption made is that, according to the impulse approximation, the amplitude for the over-all process is the sum of corresponding amplitudes for the two individual nucleons making up the deuteron. The fact that the nucleons are not at rest with respect to the deuteron center of momentum is taken into account by performing an appropriate average over the internal momentum of the deuteron in a non-relativistic approximation. This leads to a dependence on the deuteron wave functions through what are known as the deuteron form factors. The single nucleon amplitudes are taken from the simplest form resulting from dispersion relations. An interesting consequence of the isotopic singlet nature of the deuteron is that only one isotopic component contributes to the amplitude. In the static approximation used, this causes the nucleon charge and magnetic moment form factors to enter only in the vector combination $\mu^V(\lambda^2)$. The results are valid only for the energy range for which the $j = {}^3/_2$, $I = {}^3/_2$ scattering phase shift is expected to dominate the behavior. Numerical computations yield cross sections of magnitude somewhat less than 10^{-35} cm^2/Mev (sterad)^2. Empirical relations are used in the derivation for the nucleon and deuteron form factors and the pion-nucleon scattering phase shifts. (TCO)

4466 A TEST OF THE $|\Delta I| = {}^1/_2$ RULE IN $K \to 3\pi$ DECAYS. Donald Stern. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 84p.

Studies were made on the interactions of negative pions of various momenta (1035 to 1325 Mev/c) in a 72 inch hydrogen bubble chamber. As a test of the $|\Delta I| = {}^1/_2$ rule in nonleptonic decays, $K_2^0 \to \pi^+ + \pi^- + \pi^0$ was looked for and the partial rate was compared with the $K^+ \to \pi^0 + \pi^0 + \pi^+$ partial rate. The rate was calculated to be $(2.84 \pm 0.71) \times 10^6$ sec^{-1}, in excellent agreement with the prediction of the $|\Delta I| = {}^1/_2$ rule, $(2.87 \pm 0.23) \times 10^6$ sec^{-1}. (TCO)

4467 I. THEORY OF PARTICLES WITH ARBITRARY SPIN. II. PHOTOPRODUCTION OF Tm^{173}. David Leo Weaver. Thesis, Ames, Iowa, Iowa State Univ., 1963. 121p.

A c-number theory for a single particle with mass m and arbitrary spin s is presented. The starting point of the theory is the unique rest system of the particle. In the rest system the differential equations describing the time development of the particle are greatly simplified. To construct the theory in the laboratory system, it is assumed that the functions are symmetric spinors and applies the Lorentz transformation rules. By the extension of the notion of the Foldy-Wouthuysen transformation as the Lorentz transformation out of the rest system to arbitrary spin, the laboratory system Hamiltonians analogous to the spin one-half Hamiltonian can be calculated. In addition the theory provides the plane wave solutions of the laboratory system wave equation as well as the transformation properties of the solutions with respect to the inhomogeneous proper Lorentz group, the reflections, and charge conjugation. The massless limit of the arbitrary spin theory is a 2s + 1− component spinor theory that contains the two-component neutrino and the photon as well as all higher spins. In connection with the massless limit it was found possible to write the integrals of the motion as a double integral on coordinates of the spinors and displacement operators. The radioactive nuclide Tm^{173} was produced in an electron synchrotron by a (γ, P) reaction on Yb^{174}. Tm^{173} was found to decay to Yb^{173} by negatron emission with a half life of eight hours and with gamma rays of 50, 170, 230, 400, and 450 kev. From the decay characteristics, energy levels in Yb^{173} at 170 or 230, 400, and 450 kev are proposed. (TCO)

4468 SOME TOPICS IN THE S-MATRIX THEORY OF ELEMENTARY PARTICLES. Dan Webb Schlitt. Thesis, Seattle, Univ. of Washington, 1963. 74p.

The validity of the pure S-matrix approach to the theory of elementary particles was investigated by examining the mathematical structure of some model theories. The relation of this approach to conventional Lagrangian field theories, and the effects of various approximations were examined. The exact solution was obtained in a two-dimensional universe for a model in which only one kind of particle, a spinless boson, exists, and the scattering amplitudes are analytic functions of the momenta of the external particles with only those singularities required by unitarity and crossing symmetry. It was also assumed that a two particle state can make transitions only to other two particle states. The model possesses a large number of solutions distinguished by the number of zeros in the amplitude and by its asymptotic behavior. One class of solutions was investigated in detail; it was found that these solutions are in agreement with conventional perturbation theory with a $\lambda\phi^4$ interaction through terms of order λ^3. The effects of crossing symmetry and inelastic processes were investigated by means of modifications of the model. In addition to the two-dimensional model, a more realistic problem was also investigated. The four dimensional neutral scalar model is written in a form that can be solved approximately without making use of a partial wave expansion; inelastic processes are again neglected. In the simplest approximation it is impossible to generate physically reasonable bound states; the possibility of a similar behavior in the exact solution is discussed, but no definite conclusion was reached. The approximate solution obtained was compared with other models that allow only s-wave interaction; reasonable agreement was observed in the low energy region. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4469 THE PRODUCTION OF PIONS BY POSITIVE K MESONS ON NUCLEONS. Henry Eugene Fisk. Thesis, Los Angeles, Univ. of California, 1963. 87p.

Reactions of K^+ mesons with protons and neutrons were studied. Data were obtained by exposing a 15 in. hydrogen–deuterium bubble chamber to a separated beam of K^+ mesons at momenta of 642 and 810 Mev/c and photographing the tracks in the chamber. Measurement of the bubble chamber tracks yielded data that were used to kinematically separate the events into the reactions. From the separated events the total cross sections were determined. For the $K^+p\pi^-$ events there is a strong forward peaking of the K^+ and backward peaking of the proton. The $K^0p\pi^+$ Dalitz plot exhibits an increasing density of events with increasing pion energy. The one pion exchange model (OPE) gives an adequate description of the forward-backward peaking effects of the $K^+p\pi^-$ events, but the $K^0p\pi^+$ data could not be interpreted as a single dominant process. For this reason, two amplitudes in a mixed isotopic spin representation were chosen to fit the total cross sections and Dalitz plots. This mixed representation consists of: an OPE ($T_{K\pi} = \frac{1}{2}$) amplitude to account for the OPE results of the $K^+p\pi^-$ events; and a non-OPE ($T_{\pi N} = \frac{3}{2}$) amplitude to account for the expected resonance effects of the π^+p state, respectively. The qualitative agreement with the Dalitz plots and the good fit to the total cross sections indicate that these two amplitudes dominate the reactions. (TCO)

4470 CONSEQUENCES OF SYMMETRY GROUPS FOR ELECTROMAGNETIC PROPERTIES. A. J. MacFarlane and E. C. G. Sudarshan (Univ. of Rochester, N. Y.). 9p. (CONF-122-18)

From International Conference on Nucleon Structure, Stanford, Calif., June 1963.

The electromagnetic properties of SU_3 supermultiplets are obtained formally by a unitary transformation of a theory whose SU_3 invariant strong interactions are perturbed by merely charge-independent interactions. Several new results are presented, but the emphasis is on the simplicity and power of the method. Electromagnetic properties of the first and second kinds are distinguished, the former being independent of the precise manner in which the particular electromagnetic property depends on the electric charge current density. It is shown that all except two relations between the magnetic moments of the baryon octet hold equally well for other electromagnetic properties like self energies and Compton scattering amplitudes. (auth)

Field Theory and Quantum Mechanics

4471 (UCRL-10700) ANALYTICITY OF REGGE POLE TERMS. C. Edward Jones (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 26, 1963. Contract W-7405-eng-48. 9p.

A formula for single Regge pole terms is proposed that produces the correct analyticity in momentum-transfer, while retaining the correct behavior in the asymptotic region of the crossed channel and near the pole. (auth)

4472 (UCRL-10716) ON THE UNIQUENESS OF CERTAIN STANDING WAVES OF FINITE AMPLITUDE. Paul Concus (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 7, 1963. Contract W-7405-eng-48. 11p.

A uniqueness condition introduced for finding the higher-order effects for two-dimensional finite-amplitude standing gravity waves is considered. The condition, which excludes certain fluid depths, is shown to be unacceptable because it is impossible to satisfy in practice. A revision of the condition is suggested that retains the validity of the other aspects of the method. The revision also pertains to forms of the uniqueness condition that can be used to extend the method to the solution of more complex standing wave problems. (auth)

4473 REMARK ON THE FUTURE TUBE. Armin Uhlmann (Karl-Marx-Universität, Leipzig). Acta Phys. Polon., 24: 293(Aug. 1963).

It is noted that the (open) future tube T^+ is holomorphic equivalent to a well known irreducible bounded symmetric domain. The group Γ of biholomorphic maps T^+ onto T^+ is transitive and consists of the orthochronous conformal transformations continued into T^+. (C.E.S.)

4474 THE CLOSURE OF MINKOWSKI SPACE. Armin Uhlmann (Karl-Marx-Universität, Leipzig). Acta Phys. Polon., 24: 295-6(Aug. 1963).

A suitable closure of Minkowski space is given that may be used to study asymptotical flat metrics. Minkowskian coordinates are singular at infinity. Coordinates, which are regular at infinity, are introduced to resolve the singularities of the field quantities. The closure of Minkowski space gives a compact real-analytic manifold that is closely connected with the structure of the future tube. The world points at infinity constitute a closed light cone. The conformal group acts as a regular transitive group on the closed space-time. (C.E.S.)

4475 ELECTRON VELOCITY DISTRIBUTIONS IN GASES. Joseph C. Bowe (Argonne National Lab., Ill.). Am. J. Phys., 31: 905-12(Dec. 1963).

An analytical expression for the velocity-distribution function for the low-energy region ($u < u_1$) is obtained from the Maxwell-Boltzmann transport equation on the assumption that inelastic collisions occur at $u = u_1$. The exact linear differential equation that defines the distribution function in the high-energy ($u > u_1$) region is also derived. The mathematical difficulties and the usual approximations that are associated with this equation are briefly examined. An approximate analytical solution is given in terms of Hankel functions of the first kind when the cross section for inelastic collisions is assumed to be proportional to $(u - u_1)^7$. The theory, which is developed in an elementary formalism, applies to electrons that are in a uniform d-c electric field. Physical interpretations and the effects of inelastic collisions are emphasized. (auth)

4476 A CLASSICAL ANALOG FOR RELATIVISTIC CONTRACTION. Lewis Epstein (Philco Corp., Palo Alto, Calif.). Am. J. Phys., 31: 913-15(Dec. 1963).

It is possible to construct a mechanical model that demonstrates the Fitzgerald contraction. An equation is derived to describe the shape of a dimple moving across an elastic membrane, clearly showing the analogy to the field of a point charge in free space, including the relativistic contraction in the direction of motion. This model should suggest some reason to the inquiring mind that persists in wondering—"what really makes it shrink." (auth)

4477 PROBABILITY-CONSERVING TRANSFORMATIONS AND SUPERSELECTION RULES IN QUANTUM THEORY. L. O'Raifeartaigh (Dublin Inst. for Advanced Studies) and G. Rasche. Ann. Phys. (N. Y.), 25: 155-73 (Nov. 1963).

A theorem due to Wigner, which states that any transformation of a Hilbert space that preserves the absolute value of the inner products is equivalent to either a unitary or anti-unitary transformation, is considered. It is pointed out that two previous proofs of the theorem are not complete, and a new proof of the theorem, considered purely from the mathematical point of view, is given. The physical meaning of the theorem, and its connection with invariances and symmetries of physical systems, is then discussed. Particular attention is paid to the case in which superselection rules are present. A second proof of the theorem is given. (auth)

4478 TRUNCATED REACTION OPERATORS. William J. Meath, Kenneth M. Sando, S. Osvaldo Goscinski, and Joseph O. Hirschfelder (Univ. of Wisconsin, Madison). J. Chem. Phys., 39: 2429-34(Nov. 15, 1963).

The reaction operator formulation for the exact solution of the Schrödinger equation is used with a truncated basis set to obtain approximate solutions. The relationship between this truncated reaction operator formalism and the Rayleigh-Ritz variational method is emphasized and shown explicitly. The truncated reaction operator and its matrix elements are discussed in general; computed and discussed for a simple example, the helium atom, using a three-membered basis set. It is shown that the reaction operator can be replaced by a function which we call the effective perturbation potential V_{eff}. Approximations to V_{eff} were computed for the ground state of helium. This function has fundamental significance and lends itself to a accurate empiricism. (auth)

4479 TIME-DEPENDENT PERTURBATION-VARIATION METHOD. Robert Yaris (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 39: 2474-7(Nov. 15, 1963).

Through the use of the time-ordered perturbation expansion, an operator equation for the time-dependent perturbation problem, of the same form as occurs in the time-independent problem, is generated. Thus, a variational method can be used to study the time-dependent case as well as the time-independent case. This variational method is used to recover the Dirac expansion as an example of a solution in series form, and it is also used to develop a simple (approximate) analytic solution as an example of a solution in closed form. (auth)

4480 MULTI-CHANNEL REDUCED WIDTH AMPLITUDE DISTRIBUTION FOR THE SYMPLECTIC ENSEMBLE. Nazakat Ullah (Tata Inst. of Fundamental Research, Bombay). Phys. Letters, 7: 153-4(Nov. 1, 1963).

A derivation of the symplectic ensemble using the principle of level independence and of functional form invariance of the distribution is presented. This ensemble applies to systems having half-integral spin and no rotational symmetry. (R.E.U.)

4481 RESONANCE MULTIPLETS AND BROKEN SYMMETRY. R. J. Eden and J. R. Taylor (Clare Coll., Cambridge, Eng.). Phys. Rev. Letters, 11: 516-18(Dec. 1, 1963).

Experimental and theoretical consequences of the fact that resonance poles may appear on more than one Riemann sheet of the S matrix are discussed. Application is made to resonances that belong to multiplets in the unitary symmetry scheme SU(3). A model is presented for the n-channel problem that is based on a sum of self-energy diagrams. The behavior of the resonance multiplets of the scheme SU(3) when the symmetry is broken is shown to be simply explained if the resonances not only have a dominant pole but also a series of shadow poles. (R.E.U.)

4482 QUANTUM ELECTRODYNAMICS. Kenneth Johnson (Massachusetts Inst. of Tech., Cambridge), Marshall Baker, and Raymond S. Willey. Phys. Rev. Letters, 11: 518-20(Dec. 1, 1963).

The unrenormalized Schwinger-Dyson equations for the Green's functions of ordinary quantum electrodynamics were examined in a systematic nonperturbative approximation scheme. It is found that finite solutions of the equations can be obtained without infinite renormalizations if the mechanical mass of the particle is taken to be zero with a finite physical mass. It is implied that all renormalization constants are finite from the asymptotic behavior of the finite unrenormalized electron and photon propagators. The breakdown of γ_5 invariance because of no mechanical mass but finite physical mass is discussed. (R.E.U.)

4483 ON THE GENERALIZED BOLTZMANN EQUATION OF A QUANTUM GAS. [PART] II. S. Fujita (Université Libre, Brussels). Physica, 29: 1087-1104(Oct. 1963).

The generalized Boltzmann equation for a homogeneous imperfect gas reported in a previous paper is found to be inadequate. For the case of Fermi-Dirac and Maxwell-Boltzmann statistics it is replaced by $(\partial \bar{n}_p/\partial t) = 2\pi \Sigma_{n'} \delta(\epsilon_{n'} - \epsilon_n) \overline{(n|\{A^\dagger|n'\}(n'|A\}_p|n)} (\bar{n}_p - \bar{n}_p)$, where n, n' stand for quantum numbers describing the free-particle system, A for transition matrix, and the double bar means that the product of occupation numbers $n_p n_1 n_2$ is to be replaced by the product of average numbers $\bar{n}_p \bar{n}_1 \bar{n}_2 \ldots$; The suffix p means that contributions only of proper linked diagrams are to be retained. The derivation of this result and the conditions of validity are critically discussed with the aid of Feynman diagrams, representing contractions referring to the n−n matrix element. A proper diagram is

defined as that which does not contain particle lines with common momenta in it. It is argued that a proper diagram represents a collision process that may or may not conserve the energy. The case of Bose-Einstein statistics is not discussed. (auth)

4484 PEIERLS' VARIATIONAL THEOREM. Harold Falk (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Physica, 29: 1114-16(Oct. 1963).

A general proof of the original and modified forms of Peierls' variational principle is presented. (C.E.S.)

Geophysics

4485 (LADC-5723) ON THE COMPOSITION OF THE EARTH'S INTERIOR. R. G. McQueen, J. N. Fritz, and S. P. Marsh (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 64p.

Numerical calculations are performed that give the equation of state of the materials composing the various regions of the earth. The results are consistent with observed seismic velocities and the known mass and moment of inertia of the Earth. Comparison of these equations of state with those obtained experimentally indicate the type of materials that may exist in the various regions. The general features of these calculations are in close agreement with the conclusions that the mantle is made up of high-density oxides of silicon and magnesium and that the core is mostly iron. Density and pressure variations throughout the earth are also obtained. (auth)

4486 (NYO-10517(p.147-8)) THE EVOLUTION OF CONTINENTS. Patrick M. Hurley [(Massachusetts Inst. of Tech., Cambridge)].

The use of isotopic relations, particularly Sr^{87}/Sr^{86} and Rb^{87}/Sr^{86} ratios, to study the evolution of the earth is discussed; and evidence that materials in the earth's crust have been coming from its interior since its early history is cited. (D.C.W.)

4487 AN IONOSPHERIC DRIFT THEORY OF AURORA AND AIRGLOW. J. H. Piddington (Commonwealth Scientific and Industrial Research Organization, Sidney). Geophys. J., 7: 415-30(1963).

An earlier theory of polar geomagnetic storms is extended to determine the drifts of neutral ionization (electrons and positive ions moving with the same velocity in a direction perpendicular to the current vector). The theory gives the system of ionospheric electric fields and this gives the drift pattern, strongest above the auroral zones but extending down to the equator. Ionospheric drifts are divided into Pedersen drift in the direction of the electric field E, and Hall drift at right angles to E; the former has a maximum value E/2B at about 120 km, the latter reaches a value E/B at about 180 km. A poleward drift of either type is associated with an upward drift and vice versa. Ions originally in the upper ionosphere above the north pole drift south along the 22 h meridian and also down into the lower ionosphere causing a great increase in ionization density at lower levels. In the auroral zone the Pedersen drift is away from the pole in the morning current cell and towards the pole in the afternoon cell. These motions are strongly divergent, in different ways in the two cells, and may lead to the formation of auroral curtains in the morning cell and of more diffuse auroral forms in the afternoon cell. Localized concentrations of ionization in the auroral zone may have secondary effects. (a) By interfering with the magnetospheric motions they may cause precipitation of geomagnetically trapped ions. (b) They may react on the magnetospheric motions more generally to cause large-scale changes in these motions and hence in the morphology of magnetic storms. (c) They may cause ionospheric winds. The theory is extended to include drift motions between the auroral zones and the equator where it may be relevant to airglow, sporadic E, and other ionospheric phenomena. (auth)

4488 TWENTY-FOUR-HOUR OBSERVATIONS OF AURORA AT THE SOUTHERN AURORAL ZONE. T. N. Davis and R. N. DeWitt (Univ. of Alaska, College). J. Geophys. Res., 68: 6237-41(Dec. 1, 1963).

The west-to-east nighttime reversal in longitudinal auroral motions is observed at auroral zone stations. Because of the high geographic latitude of the stations, it is possible to see the aurora throughout the day, and a second reversal in longitudinal motion is observed. This reversal, from eastward to westward motion, tends to occur approximately 10 hours later than the nighttime reversal. The morphology of the day-time aurora is described; it differs in several ways from that of the aurora commonly observed in the hours near local midnight at auroral zone stations. (auth)

4489 INVESTIGATION OF ELECTRON RUNAWAY IN LIGHTNING. R. D. Hill (Univ. of Illinois, Urbana). J. Geophys. Res., 68: 6261-6(Dec. 1, 1963).

Electron-sensitive photographic emulsions were placed at points where lightning strokes occurred to a 300-m tower. No tracks of high-energy electrons, which might be associated with lightning, were observed. A search for radioactivity also showed no effects of lightning. (auth)

4490 POSSIBLE IONOSPHERIC EFFECT OF A HIGH-ALTITUDE NUCLEAR EXPLOSION. D. C. Baker and J. A. Gledhill (Rhodes Univ., Grahamstown, South Africa). J. Geophys. Res., 68: 6359-60(Dec. 1, 1963).

Magnetic data that indicate the ionospheric effects of a possible Soviet high-altitude explosion are presented. (C.E.S.)

4491 A ROCKET-BORNE LOW-FREQUENCY PROPAGATION EXPERIMENT TO DETERMINE D-REGION ELECTRON DENSITIES. J. E. Hall (Radio Research Station, Ditton Park, Slough, Bucks, Eng.) and K. Bullough. Nature, 200: 642-4(Nov. 16, 1963).

Preliminary results of a rocket experiment designed to determine the height distribution of electrons in the D-region of the ionosphere are presented. From preliminary calculations the electron density at the reflection height was determined to be about 4300 cm^{-3}. (P.C.H.)

Low Temperature Physics

4492 HIGH MAGNETIC FIELDS BY MEANS OF SUPERCONDUCTORS. T. G. Berlincourt (Atomics International, Canoga Park, Calif.). Brit. J. Appl. Phys., 14: 749-58(Nov. 1963).

Recent developments in the use of superconductors for the generation of high magnetic fields are reviewed. 66 references are given. The physical bases for high-field superconductivity are discussed relative to type II superconductors, metal-insulator composites and metal-metal composites. Some characteristics of supermagnets are described, and manifestations and possible causes of current-degradation phenomena are considered. Advanced supermagnet concepts which might offer some prospect of circumventing degradation problems are explored. (auth)

4493 PREPARATION OF SUPERCONDUCTING MATERIALS. E. M. Savitskii and V. V. Baron. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 5, 3-12(Sept.-Oct. 1963). (In Russian)

A review is given on the preparation and properties of superconducting metals and alloys. Transition temperatures and effects of impurities are tabulated, and regularities in structure changes are discussed. (R.V.J.)

4494 EXPERIMENT ON NUCLEAR DEMAGNETIZATION. A. Dupré, A. Van Itterbeek, and G. Brandt (Institut des Basses Températures et de Physique Appliquée, Louvain, Belg.). J. Phys., 24: 577-80(Aug. 1963). (In French)

Rotational demagnetization of a monocrystal of cerium magnesium nitrate is used to obtain the necessary initial conditions for nuclear cooling in copper, in thermal contact with the paramagnetic salt. A description of the demagnetization apparatus and of the thermometers for the electronic and nuclear systems is given. (auth)

4495 MAGNETIC PROPERTIES OF SUPERCONDUCTING Nb–Sn SINTERED SAMPLES. G. Meyer (Universität, Giessen, Ger.). Phys. Letters, 7: 93-4 (Nov. 1, 1963).

The preparation and properties of bulk sintered samples of the system Nb–Sn are described. The properties are those of type II superconductors. Samples were prepared from powder mixtures of both components, pressed at 8 tons/cm^2, and sintered at 840 to 1500°C in evacuated, sealed-off quartz ampoules. The sintered samples were tested for Meissner effect and reversibility of the magnetization curve. (R.E.U.)

4496 SOME PROPERTIES OF A SUPERCONDUCTING Al–Fe ALLOY. F. J. du Chatenier and S. H. Goedemoed (Kamerlingh Onnes Laboratorium, Leiden). Phys. Letters, 7: 108(Nov. 1, 1963).

An impurity of 0.1 at. % Fe in Al raises the transition temperature from 1.17 to 1.50°K. The electronic specific heat coefficient and Debye temperature are given. A-c susceptibility measurements were preformed on a powdered sample and electrical resistivity measurements between 1.25 and 4.2°K on Al–Fe strips. It is concluded that the Fe impurity atoms in Al have no localized magnetic moments. (R.E.U.)

4497 NUCLEAR RELAXATION OF HELIUM 3 GAS AT THE SURFACE OF PYREX GLASS. P. Cornaz (Université, Lausanne, Switzerland). Phys. Letters, 7: 123-4(Nov. 1, 1963). (In French)

Pyrex glass possesses a definite relaxing effect on gaseous He^3. The Pyrex contains about 0.5% Fe_2O_3, which is conjectured to be the source of this relaxation. He^3 has a spin of $\frac{1}{2}$, so that quadrupole relaxation cannot occur. The results indicate, on the basis of the theory of relaxation by dipole coupling, that the correlation times of the local magnetic fields experienced by the He^3 atoms are greater than 1 nsec (which is the period of the electronic Larmor precession). The measurements are made at room temperature, so that no He^3 film can form on the glass surfaces. (T.F.H.)

4498 EXCESS FREE ENERGY OF Ne–nD_2 LIQUID MIXTURES AT 24.56°K. M. Simon (Université Libre, Brussels). Physica, 29: 1079-86(Oct. 1963).

The dew- and boiling-point method was used to investigate the P, x relations for Ne–nD_2 liquid mixtures at 24.56°K (triple point of neon). It is shown that this system splits into two phases in the concentration range 26–85% of Ne. The excess free energy is calculated and compared with the theoretical predictions of Prigogine's theory of isotopic mixtures. (auth)

4499 CURRENT STATUS OF HIGH-FIELD SUPERCONDUCTIVITY. S. H. Autler. p.3-16 of "Metallurgy of Advanced Electronic Materials. Vol. 19." New York, Interscience Publishers, 1963.

Two mechanisms are presented to account for high-field superconductivity in Nb–Zr, Nb–Ti, Nb_3Sn, and other materials. One involves current flow along filamentary paths that coincide with inhomogeneities small enough for a magnetic field to penetrate and bring about a high critical field. The second requires strong electron scattering, short coherence length, negative surface energy, and a material with a square lattice or with laminae small enough to allow field penetration and the resultant high critical field. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4500 THE SURFACE TENSION OF LIQUID HELIUM^4 AT THE LOW TEMPERATURES AND NEAR λ-POINT. Yoshimasa Narahara. Thesis, Philadelphia, Univ. of Pennsylvania, 1963. 140p.

Measurements of the surface tension of liquid He^4 were made down to 0.35°K using a booster cryostat in the early stage and a He^3 cryostat in the latter. The height difference was measured between two menisci of large and small capillaries with a cathetometer. The method was repeated using different sets of capillaries. The temperatures were measured by carbon resistors calibrated with Hg and butyl phthalate manometers in the static condition. Several special experiments were conducted in order to investigate larger scatters of the surface tension measurements below 0.6°K. An anomalous rise of the menisci found was most likely caused by heat leak, especially above the liquid surface, that is, when the gas phase above the main bath is warmer than the liquid, and that a dilute mixture of He^3 in the liquid He^4 caused an anomalous fall. Using an IBM 1620 computer, the best fit curve of a large number of data was determined between 0.35°K and 1.4°K with the least square method. The absolute values of the surface tension were about 6 per cent higher than those previously reported. It is believed that since experiments were conducted in different sets of capillaries, different experimental spaces, and different cryostats, the data are valid unless there is systematic error throughout. (TCO)

4501 MEASUREMENT OF THE SUPERCONDUCTING ENERGY GAP FOR VANADIUM BY MEANS OF ULTRASONIC TECHNIQUES. John LaDue Brewster. Thesis, Los Angeles, Univ. of California, 1963. 102p.

The ultrasonic attenuation of a hard superconductor, vanadium, was measured for the frequency range of 46 to 437 MC in the superconducting state, using the single pulse comparison technique and electronic control of the sample temperature. The observed attenuation data could be fitted throughout the temperature region with the equation $\alpha_s/\alpha_n = (2)/(e^{\epsilon/kT} + 1)$. An energy gap of 3.35 ± 0.15 kT_c at absolute zero was obtained. The ultrasonic attenuation was observed to have a square-law dependence on frequency, indicating that $q\bar{l} \ll 1$, where q is the elastic propagation constant and $\bar{l}$ the electronic mean free path. T_c was found to be about 4.54°K and dH_c/dT about 200 gauss/deg K. A transition width of 0.11°K was observed, using a-c measuring techniques. Simultaneous ultrasonic attenuation measurements indicated that the bulk effect in the transition region was small. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4502 THE EFFECT OF MICROWAVES ON JOSEPHSON CURRENTS IN SUPERCONDUCTING TUNNELING. Sidney Shapiro, André R. Janus, and Sandor Holly (Arthur D. Little, Inc., Cambridge, Mass.). 7p. (CONF-301-9)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Josephson predicted that frequency modulation of the a-c supercurrent by an applied r-f field would lead to zero slope regions in the d-c current-voltage characteristics at specified bias voltages. The periodicity of the current associated with these zero slope regions was observed by mounting Al–AlO–Sn samples in a microwave cavity resonant at 9380 Mc and studying the tunneling current vs voltage characteristic as a function of microwave power. The periodicity is shown to follow from Josephson's frequency modulation picture. (D.C.W.)

4503 MAGNETIC AND THERMAL PROPERTIES OF SECOND KIND SUPERCONDUCTORS. I. MAGNETIZATION CURVES. T. Kinsel, E. A. Lynton, and B. Serin (Rutgers Univ., New Brunswick, N. J.). 17p. (CONF-301-8)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The magnetization curves of indium cylinders containing from 1.5 to 4.0 at. % bismuth in solid solution were measured as a function of temperature. Excellent agreement with the predictions of the Ginzburg-Landau-Abrikonov (GLA) theory was obtained near T_c. The temperature dependence of the upper critical field agreed well with Gorkov's calculations. With the appropriate temperature dependent Ginzburg-Landau parameter, the GLA theory describes the magnetization curve at any temperature. (D.C.W.)

4504 FIELD AND ANGULAR DEPENDENCE OF CRITICAL CURRENTS IN Nb_3Sn. G. D. Cody (RCA Labs., Princeton, N. J.), G. W. Cullen, and J. P. McEvoy, Jr. 13p. (CONF-301-20)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Measurements on the field and angular dependence of critical currents in thin strips of Nb_3Sn are extended to lower temperatures (4.2°K) and to single-crystal whisker samples of Nb_3Sn. The temperature-dependence of the critical current of a strip sample in a 7.4 kilogauss longitudinal field is studied. (R.E.U.)

4505 ORBITAL PARAMAGNETISM AND THE KNIGHT SHIFT IN TRANSITION METAL SUPERCONDUCTORS. A. M. Clogston, A. C. Gossard, V. Jaccarino, and Y. Yafet (Bell Telephone Labs., Inc., Murray Hill, N. J.). 20p. (CONF-301-16)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Some aspects of the Knight shifts in superconducting metals are considered. It is shown that for the transition metals orbital contributions are of prime importance. For the intermetallic superconducting compounds V_3Si and V_3Ga a relatively large degree of spin pairing is manifest below T_c in keeping with the predictions of the BCS theory. The effects of spin orbit scattering on the Knight shift are shown to be small in this case because of the short correlation distance. (auth)

4506 REDUCTION OF THE LATTICE THERMAL CONDUCTIVITY OF SUPERCONDUCTORS DUE TO POINT DEFECTS. P. G. Klemens (Westinghouse Electric Corp., Pittsburgh) and L. Tewordt. 11p. (CONF-301-1)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The ratio of the thermal conductivity in the superconducting state to that in the normal state was calculated as a function of $t = T/T_c$ for several In–Tl alloys using a theory that accounts for the different frequency dependences of phonon scattering by electrons and point defects. The results show that the reduction of the ratio due to point defects becomes appreciable for $t < 0.7$ and that it increases rapidly with decreasing t. Comparison with experimental data for In–Tl and In–Hg alloys shows that the point defect scattering substantially reduces the experimental-theoretical discrepancy. (D.C.W.)

4507 THE MEASUREMENT OF THE SPEED OF CRYOPUMPS. W. W. Stickney and B. B. Dayton (Consolidated Vacuum Corp., Rochester, N. Y.). 35p. (CONF-209-11).

From American Vacuum Society Meeting, Boston, Oct. 1963.

The cryopumping speed of a disk cooled to 10.2°K for nitrogen is measured using a tubulated gage and a nude gage in a cylindrical test dome. A theoretical analysis of the system gives calculated sticking coefficients in the neighborhood of 1.00. Equations are presented for the effect of the length and diameter of the test dome on the gage readings. The equations predict and the data tend to confirm that the beaming effect of a test dome of diameter equal to that of the disk can result in maximum speeds for nitrogen as high as 29 liters-sec^{-1}-cm^{-2} with the nude gage and about 33 liters-sec^{-1}-cm^{-2} with a tubulated gage located adjacent to the cryosurface. (auth)

4508 EXACT SOLUTION OF THE GINZBURG-LANDAU EQUATIONS FOR SLABS IN TANGENTIAL MAGNETIC FIELDS. Paul M. Marcus (IBM Watson Research Center, Yorktown Heights, N. Y.). 22p. (CONF-301-21).

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Exact solution of the one-dimensional Ginzburg-Landau equations for slabs of both small and large kappa materials leads to detailed description of the effect of a tangential external field. Typical type II behavior is found for thick slabs of large kappa material with a (first-order) phase transition at a lower critical field to a second superconducting phase, and a (second-order) phase transition to the normal state at an upper critical field. The solution in the high-field phase consists of a superconducting core surrounded by nearly normal material, and thus resembles the intermediate state more than the mixed state. A sequence of solutions in which the order oscillates about zero is shown to exist, and can be locally stable, but the state of lowest free energy is shown to be always nodeless. (auth)

4509 TEMPERATURE AND MAGNETIC FIELD DEPENDENCES OF THE JOSEPHSON TUNNELING CURRENT. Milan D. Fiske (General Electric Research Lab., Schenectady, N. Y.). 11p. (CONF-301-18).

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

A search was made for Josephson tunneling in sandwich junctions of various combinations of Al, Sn, Pb, and Nb. Zero-voltage tunneling was studied as a function of temperature and magnetic field, and gave support to Josephson's prediction. The conventional tunneling characteristic for some junctions was reached not by a single continuous jump, but in a series of steps that occurred at constant voltage. These steps are associated with modes in the a-c currents developed across the junction at nonzero d-c volt-

ages as required by Josephson. It is concluded that the zero-voltage current, which may approach the theoretical Josephson current, is altered or destroyed in a magnetic field larger than 1 gauss. (R.E.U.)

4510 FAR INFRARED ABSORPTION IN SUPERCONDUCTING LEAD ALLOYS. J. D. Leslie and D. M. Ginsberg (Univ. of Illinois, Urbana). 42p. (CONF-301-17)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Measurements were made at 1.3°K of the absorption of far infrared radiation in the surface of bulk samples of superconducting alloys composed of lead with various amounts of thallium, bismuth, or tin. The data provide the first direct experimental evidence for a sharp gap edge in superconducting alloys. The width of the energy gap decreases as thallium or tin is added to lead, and increases as bismuth is added. For concentrations up to 7.7 at. percent thallium the fractional decrease in the gap width is approximately proportional to the fractional decrease in the critical temperature, but is significantly greater than the latter for 10.0 at. percent thallium. The steepness of the absorption edge is roughly the same in all of the samples, and is greater than was expected from theoretical calculations, although these were performed in the extreme anomalous limit, which none of our samples strictly satisfy. The structure that was previously observed on the absorption curves of pure lead and mercury is also present in all of our alloys, indicating that it is probably not a result of anisotropy. (auth)

Neutron Physics

4511 (CONF-250-13) ELASTIC NEUTRON SCATTERING FROM Fe, Ni, Cu. S. A. Cox (Argonne National Lab., Ill.). [1962]. Contract W-31-109-eng-38. 15p.

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Canada, Aug. 1963.

A pulse-shape discrimination neutron detector was used to make measurements of the total neutron cross section and the differential scattering cross section at 7 angles for iron, nickel, and copper. The neutron detector operated with high detection efficiency for neutron energies greater than 400 kev. The gamma rejection ratio was high so that there was only a small contribution to background. Rejection of inelastically scattered neutrons and the lower energy neutron group from the Li(p,n) reaction was achieved by proper choice of bias on the linear spectrum. Neutron energy resolution was ~20 kev, and all data were corrected for flux attenuation and multiple scattering. (auth)

4512 (GA-4292) INELASTIC NEUTRON SCATTERING IN LIQUID METHANE AND LIQUID PARAHYDROGEN. W. L. Whittemore (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 5, 1963. Contract AT (04-3)-167. 19p. (CONF-46-98)

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

The General Atomic neutron velocity selector was used at the electron linear accelerator to study the inelastic scattering by liquid methane and liquid parahydrogen of monoenergetic neutrons with incident energies in the range 0.009 to 0.17 ev. The energy dependence of the total cross sections and the neutron spectra produced by small specimens of these materials were also measured. The inelastic scattering of slow neutrons (<0.010 ev) at 90° by liquid parahydrogen appears to be smaller than expected on the basis of the measured total cross section, assuming isotropic scattering. Perhaps this is related to the fact that the total cross section is larger than for freely rotating molecules, indicating the possible existence of some hindrance to molecular motion. The logarithmic energy decrement, $\ln E_0/E$, a quantitative measure of the neutron moderating ability, is evaluated from the measured inelastic neutron-scattering data and compared for various neutron energies for the two liquids. A consideration of the various data leads to the conclusion that methane is better than liquid parahydrogen for production of very "cold" neutrons, though for production of neutrons with energies substantially greater than 0.010 ev, liquid parahydrogen is probably more effective. (auth)

4513 (GA-4638) SCATTERING KERNEL FOR BERYLLIUM. James A. Young (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 31, 1963. Contract AT(04-3)-167. 27p. (CONF-187-20)

From American Nuclear Society Meeting, New York, Nov. 1963.

The frequency spectrum of lattice vibrations in Be is computed, using a central-force model with up to fifth-nearest-neighbor interactions. This spectrum is used to find the kernel for slow neutron scattering by Be, in the incoherent approximation. This kernel is calculated by means of an IBM 7090 code (SUMMIT), and can be determined for any temperature. The frequency spectrum is also used to calculate coherent elastic scattering by Be. Coherent inelastic scattering is not considered. (T.F.H.)

4514 (NAA-SR-8621) THE AGE OF FISSION NEUTRONS TO INDIUM RESONANCE ENERGY IN WATER. PART I. EXPERIMENT. R. K. Paschall (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 30, 1963. Contract AT-11-1-GEN-8. 38p.

The age to 1.46 ev was measured using a plane fission source of finite diameter and essentially infinite plane detectors. This is equivalent to a measurement using axial detectors with an infinite plane source. Thus, unlike recent measurements that used axial detectors with large plane sources, the results do not require calculated corrections to extrapolate to infinite source geometry. The remaining corrections are small and well understood. The age obtained was 26.45 ± 0.32 cm^2 at a density of 1.0 gm/ml. (auth)

4515 STUDY OF THERMAL NEUTRON SOURCES. R. D. Vasil'ev, G. A. Dorofeev, G. S. Mordovskaya, V. I. Petrov, and M. I. Pimenov. At. Energ. (USSR), 15: 200-4 (Sept. 1963). (In Russian)

Thermal neutron sources used for the calibration of industrial instruments must have a low γ background and a Maxwellian thermal neutron distribution; it is desirable to be able to vary the neutron flux density. The thermal column of a reactor fulfills the requirements but it is not convenient to use. On the other hand, a fast-neutron source placed in a large block of a moderating material represents a satisfactory and conveniently usable high-density source. The properties of 2 sources, consisting of a 15 and a 20-cm diameter spherical paraffin block and a Be α-source placed at the center were therefore determined. The neutron yield was measured by means of the Cd difference, using a graphite prism and BF_3 counters. The portion of the thermal neutrons leaving the sphere was found to vary from 0.11 to 0.13, depending whether a Pu–Be, Po–Be, Ac–Be, or Ra–Be α-source was used. The slow-neutron spectrum emitted by the 20-cm diameter source heated to 80°C was found to correspond to a 540°K Maxwellian distribution.

The measurements were carried out with the linear accelerator of the Kurchatov Institute. (TTT)

4516 RELAXATION OF THE NEUTRON GAS TEMPERATURE. E. Ya. Doil'nitsyn, A. G. Novikov, I. P. Stakhanov, and A. S. Stepanov. At. Energ. (USSR), 15: 255-8(Sept. 1963). (In Russian)

The spectra of thermal neutrons were measured in water at various distances from a spherical source, in order to determine the temperature of the neutron gas. The spectrum of the source was obtained by means of the cadmium difference; it exhibited a Maxwellian distribution and a temperature exceeding considerably the temperature of the water, which acted as the moderator for the collimated beam from the reactor. The beam was directed onto the water container by means of a tube which terminated in the center of a 40-mm diameter Pb sphere, serving as the source. The chopper used for the measurements had a resolution of about 40 μsec per meter at 3000 rpm and a flight path of 3 m. The results obtained by means of a 256-channel analyzer showed that at a distance larger than 20 mm from the sphere, the experimental points agree well, within the limits of the experimental error, with the Maxwellian distribution at the temperature of the medium. At shorter distances, the anisotropy caused by "hot" neutrons becomes noticeable. The following neutron temperatures were obtained: 317 ± 15°K for 10 mm, 360 ± 28°K for 5 mm, and 500 ± 28°K for 0 mm. The neutron gas temperature was computed by solving the kinetic equation. (TTT)

4517 CALCULATION OF NEUTRON SPECTRA WITH THE HELP OF THE CASE-WIGNER METHOD. J. Hejtmanek (Osterreichische Hochschule, Vienna). Atomkernenergie, 8: 346-9(Oct. 1963). (In German)

A review of the method of Case-Wigner for solving the transport equation in the case of anisotropic scattering is given. The possibility of extending this method to the energy dependent case was studied in two problems. (auth)

4518 THE ENERGY SPECTRUM OF FISSION NEUTRONS SLOWING DOWN IN CARBON. T. H. Axford (Univ. of Melbourne). J. Nucl. Energy, Pt. A & B, 17: 385-8(Nov. 1963).

The equation for the slowing down of fission neutrons in an infinite homogeneous medium is solved numerically for carbon by expanding the integral term approximately using Weddle's rule. A recurrence relation for the collision density is then obtained. The effects of anisotropic elastic scattering are included using recent experimental data. The calculated collision density spectrum is thought to be reasonably accurate up to 2 Mev, although at higher energies uncertainties in experimental data cause large probable errors. The effect of inelastic scattering is examined by regarding it as an absorption process and found to be significant above 2 or 3 Mev, but less important than the effects of anisotropy. (auth)

4519 THERMAL NEUTRON DIFFUSION PARAMETERS OF HEAVY WATER. G. Kussmaul and H. Meister (Kernforschungszentrum Karlsruhe, Ger.). J. Nucl. Energy, Pt. A & B, 17: 411-15(Nov. 1963).

The decay of the asymptotic thermal neutron distribution was measured by the pulsed technique in D_2O (99.82 mole per cent, ϑ = 22°C) in a large range of geometrical buckling ($0.0013\ cm^{-2} < B^2 < 0.0470\ cm^{-2}$). In the lower buckling region ($B^2 < 0.0060\ cm^{-2}$) a modal analysis method was used. From the experimental decay constant α plotted against B^2, the diffusion constant $D_0 = (2.000 \pm 0.009) \times 10^5\ cm^2/sec$ and the diffusion cooling constant $C = (5.25 \pm 0.25) \times 10^5\ cm^4/sec$ were obtained. (auth)

4520 INFLUENCE OF A MAGNETIC FIELD ON NEUTRON SCATTERING BY FERROMAGNETS NEAR THE CRITICAL POINT. J. Villain (CEN, Saclay, France). J. Phys., 24: 622-32(Aug. 1963). (In French)

The static spin correlations in a ferromagnet are derived from simple thermodynamical assumptions, similar to those made by Landau and Lifshitz in the theory of Weiss domains. These quantities are related to the intensity of magnetically scattered neutrons near the Curie point, if the momentum transfer is small enough. The cross section for unpolarized neutrons is given in terms of the correlations. It is found that, for a given magnetic field and temperature, the Van Hove formula is verified for weak dependences upon field and temperature. The variation with field is studied, making simple assumptions on the magnetization curve. The results are compared with the experimental data for iron. To give a realistic idea of the variation of the parameters, they are calculated using the constant coupling approximation. (auth)

4521 EXPERIMENTAL STUDY ON NEUTRON ENERGY SPECTRA DURING MODERATION IN THE THERMAL REACTOR. Hideo Kuroi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 832-41(Oct. 1963).

Effects of neutron leakage and absorption on neutron energy spectra during moderation were studied experimentally by using resonance foils of In, Au, Co, and Mn and also by using the information obtained with BF_3 and U^{238} fission counters. The influence of neutron leakage and absorption was measured separately by activation measurements with these foils at the center of critical systems using UO_2SO_4 and D_2O as fuel and moderator, respectively, and it was indicated that the neutron spectrum had a break point in the vicinity of 100 ev due to the combination of these two effects, especially in the systems of high fuel concentration. The space dependence of intermediate neutron energy spectra in the reflected systems was also investigated. A considerably wide 1/E neutron spectrum was observed at a small distance outside the core-reflector interface and a peak of neutron leakage was also observed at a small distance inside the same interface. (auth)

4522 ON THE ENERGY MODERATION OF NEUTRONS IN A HEAVY MONATOMIC GAS. Paul L. Chambré (Univ. of California, Berkeley). Rev. Union Mat. Arg. Asoc. Fis. Arg., 21: 138-43(1963).

The space- and energy-dependent neutron spectrum in a heavy monatomic gas due to a point source, as described by the Wilkins differential equation for the case of constant neutron scattering cross sections was investigated. Utilizing Laplace transformation methods the solution (Green's function) is given in closed analytical form. (auth)

4523 TIME-DEPENDENT NEUTRON TRANSPORT. Davut Bahar Ebeoglu. Thesis, Troy, N. Y., Rensselaer Polytechnic Inst., 1962. 166p.

The space and time dependence of the flux in one-dimensional slab geometry is considered for non-multiplying media. Time dependent approximations to the neutron transport equation, using a group representation for the energy dependence, were examined and are discussed. A formal, non-separable solution was obtained for slab geometry for diffusion theory, P_1 and DP_0 approximations. An infinite sized medium and a finite sized medium subject to the boundary condition of zero flux at the extrapolated boundary were both considered. Homogeneous solutions and solutions due to arbitrary sources were obtained using the Laplace transform and Green's

functions. A formulation of the problem is presented for P_3 theory. For the infinite sized medium diffusion theory and P_1 approximation solutions were compared and the wave-front corrections to diffusion theory are given and discussed. Eigenfunctions containing a separated real exponential time dependence were found for the P_L and the double P_L approximations. These solutions do not always form an infinite set. It is shown that solutions of this form do not exist in higher order approximations for slabs of small enough width. The solutions given by some low order approximations in these cases were of questionable significance. For these systems the higher approximations yield complex eigenvalues and give rise to traveling waves. The total number of eigenvalues was seen to increase with the order of the approximations in order to fit the more general initial conditions demanded by the higher order equations. In addition, for limiting cases, the eigenvalues are given as simple functions of the lifetimes for elementary processes. Some particularly interesting cases arise when an energy group is weakly coupled to other groups. Also some aspects of simple lattices were treated by single thermal group theory. Application to and interpretations of lifetime and spectrum experiments in water and beryllium were used as numerical examples of hydrogenous and crystalline media. The influence of boundary conditions on the eigenvalues of the higher buckling modes is pointed out. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4524 NEUTRON GENERATOR. V. A. Emel'yanov and L. I. Beskin. Russian Patent 154,623. Oct. 14, 1963. Filed Sept. 21, 1962.

The generator contains a stationary cylinder with beryllium targets and a cylinder with an α-emitter. The two cylinders are arranged coaxially. To achieve pulsed operation of the generator, the α-emitter cylinder is fixed and a movable cylindrical shield, with openings along its generatrices, is provided. The shield is located between the first two cylinders coaxially to them. (OTS)

Nuclear Properties and Reactions

4525 (BNL-7349) TOTAL NEUTRON AVERAGE CROSS SECTIONS IN THE kev REGION AND THE OPTICAL MODEL. A. P. Jain, R. E. Chrien, J. A. Moore, and H. Palevsky (Brookhaven National Lab., Upton, N. Y.). [Sept. 10, 1963]. Contract [AT(30-2)-Gen-16]. 4p. (CONF-327-3)

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

The average total neutron cross sections for Nb, Mo, Rh, Ag, Cd, and In are measured at 10 to 100 kev, and the values obtained are used to calculate the optical-model parameters of the nuclei. The neutron energies used fall in the region of the P-wave giant resonances in these nuclei. (T.F.H.)

4526 (CEA-2348) EVOLUTION DES QUANTITES DE NUCLEIDES LORS DE TRANSFORMATIONS RADIOACTIVES. 1. MISE EN EQUATION MATRICIELLE. (Evolution of the Amounts of Nuclides During Radioactive Transformations. I. Establishment of the Matrix Equation). R. Pottier, R. Berger, and M. Ghisoland (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). 1963. 52p.

The problem of the evolution of the amounts of nuclides during radioactive transformations is resolved according to the classical laws of radioactivity by using systematics in which the nuclides and their nuclear parameters are indexed. This method involves a simple classification of the nuclear parameters according to their nature. It leads to a matrix equation, which can be solved by a computer program. Calculations have been made with the IBM 7090-94 computer. (auth)

4527 (CONF-285-4) DEFINITIONS OF COMPOUND STATES. G. Breit (Yale Univ., New Haven). Nov. 1963. Contract AT(30-1)-1807. 21p.

From 7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963.

Critical and clarifying remarks are made concerning the compound-nucleus theory of nuclear reactions. (T.F.H.)

4528 (CONF-303-9) NUCLEAR ORIENTATION USING THE MÖSSBAUER EFFECT AND A POSSIBLE PARITY EXPERIMENT. M. Morita (Virginia. Univ., Charlottesville and Kyoto Univ. Research Inst. for Fundamental Physics) and R. Morita (Kyoto Univ.). [nd]. Contract [AT (40-1)-2400]. 22p.

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

In the successive transitions of the beta and gamma decays, the excited and ground states of the daughter nucleus are effectively polarized, when satellites of the Mössbauer effect are separately observed. Using this nuclear polarization, various precision experiments can be designed for testing parity nonconservation in beta decay. As an example, a formula for the relative intensity of the beta ray in coincidence with a Mössbauer satellite, $m_2 \rightarrow m_3$, is given in a decay scheme, $j \xrightarrow{\beta} j_1 \xrightarrow{\gamma_1} j_2 \xrightarrow{\gamma_2} j_3$, where the γ_1 ray is unobserved. A numerical calculation is performed for the decay of Mn^{57}. (auth)

4529 (CONF-327-4) FLUCTUATIONS IN THE EXCITATION FUNCTION FOR ELASTIC AND INELASTIC SCATTERING OF PROTONS FROM Ni^{62}. J. K. Dickens, F. G. Perey, and R. J. Silva (Oak Ridge National Lab., Tenn.). [1960]. Contract W-7405-eng-26. 4p.

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

Fluctuations in the excitation functions for elastic and inelastic scattering of protons by Ni^{62} are measured at scattering angles of 60 and 90°. The proton energy ranges used are 4.0 to 4.1 Mev and 8.0 to 8.1 Mev. If the observed fluctuations are associated with compound nuclear states, it is noted that these states have lifetimes of approximately 10^{-19} sec. (T.F.H.)

4530 (EANDC-33U(p.14-23)) THE FISSION CROSS SECTION OF Pu^{239} FROM 1 kev TO 160 kev. G. D. James (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The fission cross section of Pu^{239} from 1 to 160 kev is measured by time-of-flight experiment using 40 mg Pu^{239} and a 15 m flight path. The experimental method is described and the accuracy of the results is discussed. (auth)

4531 (EANDC-33U(p.41-3)) REMARKS ON ABSOLUTE HEAVY-ELEMENT NEUTRON CAPTURE CROSS SECTIONS DETERMINED BY THE SPHERE TRANSMISSION METHOD. H. W. Schmitt (Oak Ridge National Lab., Tenn.).

Neutron absorption and total cross sections are measured on Ag, In, Sb, I, and Au at a neutron energy of 24 kev, using the sphere transmission method. (T.F.H.)

4532 (EANDC-33U(p.64-86)) NEUTRON CAPTURE IN U^{238} AND THE RATIO OF CAPTURE TO FISSION IN U^{235}. L. W. Weston, G. de Saussure, and R. Gwin (Oak Ridge National Lab., Tenn.).

Large liquid scintillator tanks have been applied to the

measurement of the capture cross section of U^{238} at 30 and 64 kev, and the measurement of the ratio of capture to fission in U^{235}. The ratio of capture to fission in U^{235} is studied over a wide neutron energy range (4 ev to 700 kev) by two different methods. (auth)

4533 (EANDC-33U(p.87-101)) THE $MnSO_4$ BATH METHOD FOR NEUTRON FLUX MEASUREMENTS IN THE INTERMEDIATE ENERGY REGION. W. Poenitz and G. Brudermueller (Kernforschungszentrum. Institut für Angewandte Kernphysik, Karlsruhe, Germany).

The neutron flux from the $Li^7(p,n)Be^7$ reaction near the threshold has been absolutely determined using a $MnSO_4$ bath. Details of the experimental procedure are discussed. A preliminary measurement of the capture cross section of gold yielding 670 mb at 30 kev has been performed. (auth)

4534 (EANDC-33U(p.114-35)) NEUTRON FLUX AND CAPTURE MEASUREMENTS USING A LARGE LIQUID SCINTILLATOR. E. Haddad, R. B. Walton, S. J. Friesenhahn, and W. M. Lopez (General Atomic Div. General Dynamics Corp., San Diego, Calif.).

Neutron capture cross sections, averaged over many resonances, are measured for Au^{197}, Ag^{107}, and Ag^{109} at neutron energies of 1 to 30 kev. The measurements are made with a large liquid scintillator detector. (T.F.H.)

4535 (EANDC-33U(p.150-8)) PROPOSAL FOR THE USE OF THE ASSOCIATED PARTICLE METHOD WITH NEUTRONS OF 100 kev OR LESS. H. Beil, M. Le Rigoleur, and J. L. Leroy (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay).

The use of the associated-particle method for determining the neutron fluxes and energies from the reaction $T(p,n)He^3$ is analyzed. In this method, the He^3 distributions and fluxes are measured, and these data are used to obtain the desired information on the neutron distributions. (T.F.H.)

4536 (EANDC-33U(p.161-3)) NOTES ON SHELL TRANSMISSION THEORY. P. H. White (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

Formulas and references are given pertinent to shell-transmission theory for neutrons. (T.F.H.)

4537 (EANDC-33U(p.164-7)) THE CROSS SECTION OF THE REACTION $Au^{197}(n,\gamma)Au^{198}$ FOR 30-kev NEUTRONS. W. Poenitz (Kernforschungszentrum, Karlsruhe, Germany).

The $Au^{197}(n,\gamma)Au^{198}$ cross section is measured at the threshold of the $Li^7(p,n)Be^7$ reaction by an activation method. The absolute neutron flux is determined by counting the Be^7 activity. A preliminary value of 598 ± 60 mb is obtained. (auth)

4538 (EANDC(UK)-26U) A REVIEW OF EVALUATIONS OF NEUTRON CROSS SECTIONS AVAILABLE AT SEPTEMBER 1963. K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). 23p.

A survey of evaluation work by laboratories is given, followed by a tabular summary. Some discussion is given of the position for each chemical element and certain isotopes and chemical compounds. (auth)

4539 (JINR-E-1384) THE (p,pn) AND (p,n) REACTIONS ON Sc^{45} INDUCED BY HIGH-ENERGY PROTONS. I. Levenberg, V. Pokrovskii, Te-hou Jen, L. Tarasova, and I. Yutlandov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 15p.

The reactions (p,pn) and (p,n) on Sc^{45} have been investigated in the proton energy range of 120 to 670 Mev. The cross sections of these reactions decrease with the proton energy from ≈70 and 4 mb at 120 Mev down to ≈40 and 1 mb at 670 Mev, respectively. The influence of the nuclear structure on the cross section of the reactions under study is discussed, under the assumption of direct interaction mechanism between the incident proton and nuclear nucleons. The experimental value of the production cross section ratio of Sc^{44g} and Sc^{44m}, which is 2.2, is compared to the calculated one. The parameter σ entering into the expression for nuclear level density is estimated. (auth)

4540 (JINR-P-1369) VZAIMODEISTVIE REZONANSNYKH NEITRONOV S VYSTROENNYMI YADRAMI. (The Interaction of Resonant Neutrons with Aligned Nuclei). V. N. Efimov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1963. 14p.

It is shown that the total cross section of resonant interaction between unpolarized neutrons and nuclei is sensitive to nuclear alignment if the resonance is excited by p-neutrons. In this case the angular distributions of reaction products have azimuthal asymmetry. For s-levels the nuclear alignment leads to angular anisotropy of gamma rays emitted by capture of unpolarized neutrons. (auth)

4541 (JINR-P-1385) OSOBENNOSTI RASPADA SOSTAVNYKH YADER DISPROZIYA S VYSOKIM UGLOVYM MOMENTOM. (Some Features of Decay of Dy Compound Nuclei with High Angular Momentum). G. Kumpf and V. A. Karnaukhov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Labs. of Nuclear Reactions). 1963. 13p.

Measurements of the energy dependence of the cross sections are given for the following nuclear reactions: $Cd^{114}(Ar^{40},5n)Dy^{149}$; $Cd^{114}(Ar^{40},4n)Dy^{150}$; and $Cd^{114}(Ar^{40},3n)Dy^{151}$. The excitation functions obtained have a shape characteristic of evaporation reactions. The analysis of the experimental data is based on a generalized model (approximation of constant nuclear temperature) with account of rotation and cut-off in possible values of the spin. The calculated excitation functions are in fair agreement with experiment. (auth)

4542 (KFK-135) DIE BESTIMMUNG DER WAHREN VERTEILUNG BEI WINKELKORRELATIONSEXPERIMENTEN. (The Determination of Distribution in Angular Correlation Experiments). W. Michaelis (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H. Institut für Neutronenphysik und Reaktortechnik, Karlsruhe, Germany). Feb. 1963. 29p.

The principles of a numerical method for the determination of distribution in angular correlation experiments are given. Corrections for the geometry and interactions in the source are determined. The application of the method to the special case of γ-γ cascades was verified. (J.S.R.)

4543 (NP-13165(Vol.1)) MATERIALY TRET'EGO SOVESHCHANIYA PO NEITRONODEFITSITNYM IZOTOPAM. T.1. TYAZHELYE REDKI ZEMLI (OT Gd DO Lu), DUBNA, IYUN 20 TO 26. (Reports of the Third Conference on Neutron-Deficient Isotopes. Vol. 1. Heavy Rare Earths (From Gd to Lu), Dubna, June 20–26, 1960). (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 225p.

Twenty-six papers are included on neutron-deficient isotopes (from Gd to Lu). Separate abstracts have been

prepared for 23. Three papers were previously abstracted for NSA. (R.V.J.)

For abstracts of individual papers see: 4544, 4545, 4546, 4547, 4548, 4549, 4550, 4551, 4552, 4553, 4554, 4555, 4556, 4557, 4558, 4559, 4560, 4561, 4562, 4563, 4564, 4565, and 4566.

4544 (NP-13165(Vol.1)(p.7-22)) DETERMINATION OF THE ELECTRON CAPTURE FRACTION WHICH INDUCES THE Yb^{173} GROUND STATE DURING Lu^{173} NUCLEAR DECAY. V. I. Baranovskii and G. M. Gorodinskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A 4 π-scintillation counter with a single-channel γ spectrometer was used for determining the Lu^{173} half life and the fraction of electrons captured by the Yb^{173} ground level in Lu^{173} decay. (R.V.J.)

4545 (NP-13165(Vol.1)(p.23-31)) RADIOACTIVE DECAY OF Lu^{171} AND Lu^{172}. Z. Plajner, L. Maly, and M. Vobecky (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Relative intensities of conversion lines in Lu^{171} (8.1 days) → Yb^{171} and Lu^{172} (6.7 days) → Yb^{172} decays were determined with an accuracy of 0.1% using a double-focusing spectrometer with 0.25% resolving power and 0.6 light power. (R.V.J.)

4546 (NP-13165(Vol.1)(p.40-5)) ON $e^- - e^-$ COINCIDENCES IN Lu^{171} DECAY. B. S. Dzhelepov and V. A. Sergienko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A double-lens β spectrometer was used in studies of conversion electron coincidences in Lu^{171} ($T_{1/2}$ = 8 days) decay. The experiment was carried out using the lutetium fraction from Hf decay. Electron coincidence spectra for Lu^{171} (75.9 kev) and Lu^{172} (78.7 kev) L lines and 5 to 50 kev electrons and self-coincidence of 17-kev electrons are given. (R.V.J.)

4547 (NP-13165(Vol.1)(p.46-53)) SPECTRUM OF Lu^{170} CONVERSION ELECTRONS AT 1350 TO 3200 kev. B. S. Dzhelepov, A. I. Medvedsev, I. F. Uchevatkin, and S. A. Shestopalova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A triple-focusing β spectrometer with 1.4% resolving power was used for determining Lu^{170} conversion electron spectra at 1350 to 3200 kev. Conversion lines corresponding to 1454, 1481, 1567, and 1992 kev transitions were found. (R.V.J.)

4548 (NP-13165(Vol.1)(p.54-64)) SPECTRUM OF LUTETIUM FRACTION CONVERSION ELECTRONS. A. A. Abdurazakov, F. M. Abdurazakova, K. Ya. Gromov, B. S. Dzhelepov, and G. Ya. Umarov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Conversion electron spectra of the lutetium fraction formed in tantalum spallation were developed by β spectroscopy. Conversion lines for Lu^{172}, Lu^{171} (8.1 days) → Yb^{171}, Lu^{170} (1.9 days), Lu^{169} (1.5 days) Yb^{169}, Lu^{167} → Yb^{167} → Tm^{167}, Yb^{167} (18 min) → Tm^{167}, and Tm^{167} (9.6 days) → Er^{167} were tabulated. Two new conversion lines at 105.9 and 169.1 kev (half life = 3 hrs) were found. (R.V.J.)

4549 (NP-13165(Vol.1)(p.65-82)) ENERGY LEVELS OF Er^{166}. E. Bozek, Kh. Nevodnichanskii, S. Ogaza, S. Shimchak, and Yu. Norseev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Measurements were carried out on γ-γ coincidences in Yb^{166} decay, and a complete energy level scheme was developed for Er^{166}. (R.V.J.)

4550 (NP-13165(Vol.1)(p.83-94)) CONVERSION ELECTRONS OF Yb^{166}. E. P. Grigor'ev, K. Ya. Gromov, and B. S. Dzhelepov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A double-focusing β spectrometer was used in an investigation of electron conversion in Yb^{166} in equilibrium with Tm^{166}. The γ transition energy was determined with an order of accuracy of 0.05 to 0.10%. The transition energies from excited levels of Tm^{166} to the ground state were verified, and the decay scheme Yb^{166} → Tu^{166} → Er^{166} is given. Certain conclusions were made for the even-even Er^{166} nucleus, and the multiplicities of all transitions were assumed to be E2. (R.V.J.)

4551 (NP-13165(Vol.1)(p.95-100)) POSITRONS OF Tm^{166}. Ya. Zhilich, Yu. Norseev, Z. Preibish, S. Khoinatskii, and E. Volovskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A long-lens spectrometer with a spiral diaphragm for electron and positron separation was used in an investigation of β emission by Tm^{166} in equilibrium with Yb^{166} ($T_{1/2}$ = 57 hrs). Curie coordinates of Tm^{166} positron spectra and energy distribution reveal two β components with maximum energies of 1.9 and 1.2 Mev. It is postulated that the Tm^{166} ground state is 2^-, thus both positron components are forbidden first-order transitions. The total transition energy is 3023 kev. (R.V.J.)

4552 (NP-13165(Vol.1)(p.101-5)) INVESTIGATION OF CONVERSION ELECTRONS OF DECAY CHAIN $Yb^{164} \xrightarrow{75min} Tm^{164} \xrightarrow{2min} Er^{164}$ AT 150 TO 900 kev. K. Ya. Gromov, B. S. Dzhelepov, Zyong Chong Pai, V. A. Khalkin, and V. G. Chumin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Conversion electrons in $Yb^{164} \xrightarrow[K]{75min} Tm^{164} \xrightarrow[K,\delta^+]{2min} Er^{164}$ were studied using a β spectrometer with a uniform transverse magnetic field (light power ~0.1%, resolving power ~0.8%). The analysis was made considering positron spectrum intensity as 100 and K−208, L−208, and M−208 as verified data for the E_γ = 211 kev transition. The lines coincide at Yb^{169} energies L = 177.3 and 198.0 kev. (R.V.J.)

4553 (NP-13165(Vol.1)(p.106-11)) β^- EMISSION FROM Tm^{172}. O. Volchek, Ya. Zhilich, Z. Preibish, S. Khoinatskii, and I. Yutlandov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

It was postulated that the electron spectrum observed during an investigation of Tm isotopes prepared by proton irradiation of tantalum at 660 Mev belonged to Tm^{172}. A decay scheme for Tm^{172} is included. (R.V.J.)

4554 (NP-13165(Vol.1)(p.112-17)) STUDY OF RADIOACTIVE DECAY OF Tm^{168}. V. Brabets, B. Kratsik, and M. Vobecky (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

An analysis was made of Tm^{168} decay in two directions, towards Er^{168} and Yb^{168}. Electron capture decay toward Er^{168} is known, while its decay toward Yb^{168} is not yet known. An attempt was made to verify G. Wilkinson's (Phys. Rev., 75: 1370(1949)) postulation on Tm^{168} transition to Yb^{168} by β decay. (R.V.J.)

4555 (NP-13165(Vol.1)(p.118-23)) DETERMINATION OF Tm^{167} AND Tm^{168} HALF LIVES. E. A. Kudryashov, G. S. Novikov, and I. M. Rogachev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Three sets of measurements on Yb^{169} and Tm^{167} con-

version lines were made at 14-day intervals. The half life for Tm^{167} was found to be 9.6 ± 0.3 days and for Tm^{168}, 87 ± 12 days. The Yb^{169} $T_{½}$ was accepted as 30.6 ± 2 days. (R.V.J.)

4556 (NP-13165(Vol.1)(p.124-30)) ON THE Tm^{167} DECAY SCHEME. K. Ya. Gromov, B. S. Dzhelepov, A. G. Dmitriev, M. K. Nikitin, and K. I. Yakovlev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Conversion electrons and γ spectra of Tm^{167} were studied using a magnetic spectrometer with improved focusing, a resolving power ~0.4% and a light power of ~0.5%. The resolving power of the scintillation γ spectrometer used was 11% for the Cs^{137} 661-kev γ line. Data on the Tm^{167} hard conversion and γ spectra are tabulated. The decay scheme, within the error of γ transition measurements, does not contradict the presence of a 798-kev energy (534 + 265 kev) with two transitions, 790 and 530 kev. The multiplicities of the 534 and 790-kev transitions suggest that the 798-kev energy level is of the 5/2 [512] type. (R.V.J.)

4557 (NP-13165(Vol.1)(p.131-4)) GAMMA SPECTRA OF Tm^{167}. S. Khoinatskii, A. Yasinskii, V. Kush, Ya. Kovnatskii, G. Lantsman, and I. Yutlandov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A scintillation γ spectrometer with a 100-channel amplitude analyzer and resolving power of 7.8% for the Cs^{137} 660-kev line was used for measuring Tm^{167} spectra. The results indicate a 527 ± 10 kev line in addition to the 208-kev line. The half life of the 525-kev line is 10 days. Considering that the transitions are on the 208-kev level, negative parity and spins of $^{5}/_{2}$ and $^{3}/_{2}$ are assigned to 735-kev level. (R.V.J.)

4558 (NP-13165(Vol.1)(p.135-42)) ON THE Tm^{167} DECAY. B. S. Dzhelepov and I. M. Rogachev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A magnetic β spectrometer with intermediate acceleration and 2.2% relative line half-width at 0.44% light power was used in an investigation of the Tm^{167} conversion spectrum and Auger electrons. Relative line intensities were correlated with published data. Correlations of the K-Auger electron intensity and the 57, 1, 208.3 lines were used for determining the amount of capture at Er^{167} 265.4 and 208.3 kev levels. The total K-series Auger electron intensity is 375 units. The numbers of K captures and L captures are 4360 and 568. The total number of captures at the 208.3 level is 4920−1806 = 3114, where 63% are captured at the Er^{167} 265-kev level and 37% are captured in Tm^{167}. Capture to the Er^{167} ground state was not observed. (R.V.J.)

4559 (NP-13165(Vol.1)(p.143-8)) SOME REMARKS ON THE DECAY CHAINS $Tm^{163} \xrightarrow{2hrs} Er^{163} \xrightarrow{75min} Ho^{163} \rightarrow Dy^{163}$ AND $Tu^{161} \xrightarrow{37mis} Er^{161} \xrightarrow{3.5hrs} Ho^{161} \xrightarrow{2.5hrs} Dy^{161}$. B. Dalkhsuren, L. M. Gvozdeva, M. Ya. Kuznetsova, I. Yu. Levenberg, Yu. V. Norseev, V. N. Pokrovskii, and I. A. Yutlandov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Studies were made of γ spectra in Tm^{163} ($T_{½}$ = 2 hrs) and Tm^{161} ($T_{½}$ = 30 min) decay during Er irradiation by protons. The half life of Er^{163} is ~75 min and the γ spectrum contains lines of 430, ~1100, and possibly ~300 kev. It was found that Er^{163} decays in most cases to the Ho^{163} ground state. The half life of Tm^{161} is 37 ± 5 min. The gamma spectrum of Er^{161} ($T_{½}$ = 3.4 ± 0.2 hrs) consists of lines of 210, 825, and ~1200 kev with relative intensities of 210 : 825 : 1200 = (13 ± 2) : 100 : ~5. It is assumed that Er^{161} also has a 1418-kev level and transitions of 592 and 1207 kev. Results obtained for Ho^{161} are in good agreement with published data. (R.V.J.)

4560 (NP-13165(Vol.1)(p.149-61)) CONVERSION ELECTRONS OF ERBIUM FRACTION AT ENERGY RANGE FROM 20 TO 900 kev. A. A. Abdurazakov, K. Ya. Gromov, B. S. Dzhelepov, and V. A. Khalkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A β spectrometer with a constant magnetic field was used for determining conversion electron spectra of erbium isotopes produced by 660-Mev proton bombardment of Ta targets. Energies of γ transitions in $Er^{161} \rightarrow Ho^{161}$ and $Er^{158} \rightarrow Ho^{158} \rightarrow Dy^{158}$ were verified, and a series of new γ transition and conversion lines was found. A decay scheme for $Er^{158} \rightarrow Ho^{158} \rightarrow Dy^{158}$ was developed. (R.V.J.)

4561 (NP-13165(Vol.1)(p.162-75)) ON POSITRON SPECTRA OF NEUTRON-DEFICIENT ISOTOPES OF Ho, Tb, AND Gd. N. A. Bonch-Osmolovskaya, B. S. Dzhelepov, O. E. Kraft, and Yeh-wa Chou (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Positron spectra of neutron-deficient Ho, Tb, and Gd isotopes prepared by 660-Mev proton spallation in a tantalum target were studied. The fractions were separated chromatographically. The measurements were made with a triple-focusing β spectrometer 3 to 4 hrs after the exposure and 15 to 30 min after the column fractionation. Half-life plots are included. (R.V.J.)

4562 (NP-13165(Vol.1)(p.176-86)) ON Ho^{160} DECAY. E. P. Grigor'ev, B. S. Dzhelepov, V. Zvol'ska, and A. V. Zolotavin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A β spectrometer with double focusing at $\pi\sqrt{2}$ and 0.22% resolving power was used to determine conversion line energies and to verify nuclear excitation levels. The spectrometer was designed with a homogeneous field in the center of the gap and a transducer capable of measuring fields from 60 to 800 gauss (corresponding to electron energies from 60 to 2700 kev). Conversion lines for Ho^{160} and energy levels for Dy^{160} are tabulated. The distribution of L lines in 86.8 and 60.1-kev transitions were resolved in relation to L_I, L_{II}, and L_{III} lines, and transition multiplicities were determined. The 86.8-kev transition to the Dy^{160} ground state is E2 and the 60.1-kev transition is E3. (R.V.J.)

4563 (NP-13165(Vol.1)(p.197-208)) SPECTRUM OF CONVERSION ELECTRONS OF HOLMIUM FRACTION. A. S. Basina, K. Ya. Gromov, and B. S. Dzhelepov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A β spectrometer with 1.9% resolving power was used in an investigation of Ho conversion electron spectra at 30 to 1000 kev. Conversion lines for Ho^{158}, (T = 30 ± 5 min), Ho^{156} (T = 55 ± 5 min), Ho^{161} (T = 3 ± 5 hours), Ho^{160} (T = 5 ± 5 hours) were observed and analyzed. (R.V.J.)

4564 (NP-13165(Vol.1)(p.209-14)) ON THE SPECTRUM OF DYSPROSIUM FRACTION CONVERSION ELECTRONS. E. P. Grigor'ev, B. S. Dzhelepov, V. Zvol'ska, I. Zvol'skii, I. Adam, and V. A. Khalkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A double-focusing $\pi\sqrt{2}$ β spectrometer was used in an investigation of dysprosium conversion electron spectra at 25 to 180 kev. Relative intensities of conversion lines are tabulated. Half-life data indicate that all conversion electrons belong to Dy^{153} ($T_{½}$ = 6.4 ± 0.3 hours). (R.V.J.)

4565 (NP-13165(Vol.1)(p.215-19)) SPECTRUM OF CONVERSION ELECTRONS OF TERBIUM FRACTION.

A. A. Abdurazakov and K. Ya. Gromov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Conversion electron spectra of terbium prepared by tantalum spallation (E_p = 660-Mev) were investigated using a β spectrometer with a constant magnetic field. Identified conversion lines at 271.3 and 344.3 kev belong to Tb^{152}. It was postulated that a line observed at 165.1 kev belongs to Tb^{149}. (R.V.J.)

4566 (NP-13165(Vol.1)(p.224-5)) SPECTRUM OF Gd^{149} CONVERSION ELECTRONS AT 300 TO 1000 kev. B. S. Dzhelepov and A. I. Feoktistov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A ketone-type β spectrometer was used in an investigation of Gd^{149} conversion electron spectra at 300 kev to 1 Mev. Relative line intensities are in agreement with published data. (R.V.J.)

4567 (NP-13165(Vol.2)) MATERIALY TRET'EGO SOVESHCHANIYA PO NEITRONODEFITSITNYM IZOTOPAM. T. 2. LEGKIE REDKIE ZEMLI. RADIOKHIMICHESKIE RABOTY, DUBNA, IYUN 20 TO 26. (Reports of the Third Conference on Neutron-Deficient Isotopes. Vol. 2. Light Rare Earths. Radiochemical Studies, Dubna, June 20–26, 1960). (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 163p.

Twenty-one papers are included on properties of neutron-deficient, light rare-earth isotopes (from Tb to Pr). Data are included on the properties of Pt, Ir, Os, and W isotopes. Separate abstracts have been prepared for 14 papers; seven papers were previously abstracted in NSA. (R.V.J.)

For abstracts of individual papers see: 3811, 3812, 4568, 4569, 4570, 4571, 4572, 4573, 4574, 4575, 4576, 4577, 4578, and 4579.

4568 (NP-13165(Vol.2)(p.15-24)) GAMMA EMISSION OF CERTAIN NEUTRON-DEFICIENT Tb ISOTOPES. V. N. Belogurov, O. E. Veveris, Z. E. Pelekis, and L. L. Pelekis (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Scintillation ($\tau = 5 \times 10^{-7}$ sec) coincidence spectrometers were used to study terbium prepared by 660-Mev proton bombardment of tantalum. A 50-channel analyzer with a 20 × 30 mm NaI(Tl) crystal was used for measuring the spectra. Gamma spectra of Tb^{153}, Tb^{155}, and Tb^{156} are given. (R.V.J.)

4569 (NP-13165(Vol.2)(p.25-9)) ELECTRON COINCIDENCES IN Gd^{153} DECAY. B. S. Dzhelepov, G. S. Novikov and V. A. Sergienko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A double-lens β spectrometer was used in an investigation of electron formation in $Gd^{153} \rightarrow Eu^{153}$ decay ($T_{1/2}$ = 236 days). Coincidences between conversion electrons from the 103, 98, 70-kev transitions and between K-conversion transitions at 103 and 98 kev and Auger electrons were studied. (R.V.J.)

4570 (NP-13165(Vol.2)(p.36-8)) INVESTIGATION OF Eu^{146} DECAY SCHEME. Yu. A. Aleksandrov, V. Kroga, and M. K. Nikitin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A coincidence scintillation spectrometer with a multichannel analyzer was used in an investigation of γ emission and γ-γ coincidences in Eu^{146} decay ($T_{1/2}$ = 4.6 ± 0.3 days). The gamma spectrum was studied at energies up to 3500 kev, and transitions were found at 400, 415, 635, 667, 705, 745, 900, 1060, 1150, 1300, 1420, 1550, 1800, 2100, 2500, 2800, and 3200 kev. Relative transition intensities at 635 and 745 kev and at 667 and 705 kev were: 745 kev = 100%, 705 kev = 7 ± 2%, 667 kev = 18 ± 5%, and 635 kev = 76 ± 8%. Coincidences indicated the presence of cascade transitions at 745–635–667, 745–635–900, 745–635–1060, 745–635–1300, 635–1800, 745–1550, and 745–2100 kev. (R.V.J.)

4571 (NP-13165(Vol.2)(p.39-41)) REMARKS ON CONVERSION ELECTRON SPECTRA OF Pr^{140}. B. S. Dzhelepov, A. I. Medvedev, I. F. Uchevatkin, and S. A. Shestopalova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Measurements were made of Pr^{140} conversion electron spectra using a triple-focusing spectrometer with 1.4% resolving power. The relative intensity of the 201-kev line varied from one specimen to another. In repeated measurements the K-1597 kev and K-1902 kev lines were completely separated and an intensity of $(15 \pm 6) \times 10^{-6}$ was established; published data indicated $(14.5 \pm 5) \times 10^{-6}$. (R.V.J.)

4572 (NP-13165(Vol.2)(p.42-9)) DECAY OF $Nd^{140} \rightarrow Pr^{140} \rightarrow Ce^{140}$. V. Brabets, B. Kratsik, and M. Vobecky (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A β spectrometer with an intermediate image and 2% resolving power was used to correlate theoretical data with data obtained by C. J. Browne et al. (Phys. Rev. 85: 146(1952)) and K. Ya. Gromov et al. (Izvest. Akad. Nauk SSSR ser. fiz., 22: 153(1953)). The β spectrum for Pr^{140} is given, and the interpolated data show 10.5% for Ce^{140} Auger electron yield. For electron and positron capture in Pr^{140} $E_K/\beta^+ = 0.897$, with 50.3% electron capture and 49.9% β decay. The intensity of the strongest Auger electron groups, K – LX/K – LL, was 0.58 ± 0.05; the theoretical magnitude is 0.50. (R.V.J.)

4573 (NP-13165(Vol.2)(p.50-4)) NEW ISOTOPE Ir^{183}. A. K. Lavrukhina, T. V. Malysheva, and B. A. Khotin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Preparation and decay of Ir^{183} ($T_{1/2}$ = 1 ± 0.1 hr) were studied, and activity curves were constructed for osmium daughter decay. (R.V.J.)

4574 (NP-13165(Vol.2)(p.55-8)) CONVERSION SPECTRUM OF IRIDIUM FRACTION. V. S. Shpinel and V. M. Shumshurov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Tables of Ir internal γ conversion coefficients are developed and interpreted. Multiplicities of γ transitions at 97, 120, and 137 Mev developed in relation to L-shell conversion coefficients are also tabulated. (R.V.J.)

4575 (NP-13165(Vol.2)(p.59-61)) PRELIMINARY DATA ON CONVERSION ELECTRONS OF NEUTRON-DEFICIENT PLATINUM ISOTOPES. A. A. Abdurazakov, K. Ya. Gromov, B. S. Dzhelepov, T. V. Malysheva, and B. A. Khotin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Conversion electron spectra for neutron deficient platinum isotopes prepared by 660-Mev proton bombardment of gold were studied using a β spectrometer with a constant field. A rough estimate was made of Pt conversion lines. (R.V.J.)

4576 (NP-13165(Vol.2)(p.87-100)) REGULARITIES IN THE DISTRIBUTION OF YIELD PRODUCTS OF TANTALUM SPALLATION BY 660-Mev PROTONS. V. I. Baranovskii, A. N. Murin, and B. K. Preobrazhenskii

(Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Individual and cumulative yields of products from Ta spallation by 660-Mev protons were studied. Data for mass numbers from 120 to 160, calculated with the formula $\sigma(A,Z)_{ind} = \sigma(A)\sqrt{R/\pi}\, e^{-R(Z-SA)^2}$, (where $\sigma(A,Z)_{ind}$ are individual formation cross sections of isotopes with atomic number Z and mass A, $\sigma(A)$ is the integral yield for a given mass number, and R is a constant) are in agreement with theoretical values except for masses 146 and 149. An analysis showed the following values for the experimental parameters p, Q, S, and $\sqrt{R}$: 0.139 ± 0.003, 18.04 ± 0.06, 0.426 ± 0.002, and 1 ± 0.1, respectively. (R.V.J.)

4577 (NP-13165(Vol.2)(p.101-11)) DISTRIBUTION OF ISOBAR YIELD PRODUCED BY HAFNIUM SPALLATION BY 660-Mev PROTONS. A. K. Lavrukhina and A. A. Pozdnyakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Distribution of isobar yields for Hf spallation by 660-Mev protons was measured with an end-window counter and with a magnetic analyzer equipped with two end-window counters. The feasibility of using the Rutsdam semiempirical formula was evaluated. The isobar yields were correlated with yields from copper. Detailed measurements revealed β decay in neutron-saturated Lu^{176}, Lu^{177}, Er^{169}, and Ho^{166}. Values for the parameters p, Q, R, and S (for nuclei 20 and over nucleons from the target) were p = 0.11, Q = 12.8, R = 1.2, and S = 0.433. Calculated cross-section values for given isotopes coincide within 2% with measured values. (R.V.J.)

4578 (NP-13165(Vol.2)(p.112-16)) DETERMINATION OF THE RATIO OF CUMULATIVE YIELDS OF Lu^{169} AND Lu^{173} IN Ta + p REACTION (660 Mev). B. S. Dzhelepov, A. I. Medvedev, I. F. Uchevatkin, and A. S. Shestopalova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Conversion lines were used to determine the ratio of Yb^{169} and Lu^{173} yields in Ta + p reactions. The yield ratio was 1.6 ± 0.5. Measurements on the Yb^{169} half life indicated $T_{1/2}$ = 30.8 ± 0.3 days. (R.V.J.)

4579 (NP-13165(Vol.2)(p.121-32)) STUDIES OF CERTAIN REACTIONS OF Nd SPALLATION BY HIGH-ENERGY PROTONS. A. K. Lavrukhina, G. M. Kolesov, and Hsiao-en T'ang (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Neutron deficient cerium-group production cross sections in Nd and Eu spallation by protons were determined. Interpolated data on cross sections and half lives of identified Pm, Nd, Pr, Ce, and La nuclei were tabulated. (R.V.J.)

4580 (NP-13370) RANGE DISTRIBUTION OF Na-22 POSITRONS IN ARGON AND NITROGEN. G. J. Celitans and J. H. Green (New South Wales, Australia. Univ., Kensington). [1963]. 12p.

A two-photon coincidence apparatus was used. The distributions are compared with theoretical positron path length distributions and are used to calculate correction factors applicable to the study of positronium formation in gases. (auth)

4581 (NP-13371) NUCLEAR SPECTRA IN THE RARE EARTH REGION. AN INVESTIGATION OF THE EXCITED STATES OF ^{166}Er, ^{170}Yb AND ^{140}La (thesis). Petrus Boskma (Groningen, Netherlands. Rijksuniversiteit). 1960. 95p.

Investigations of the excited states of Er^{166} from Ho^{166} (>30 yr) and Tm^{166}, of Yb^{170} from Lu^{170} decay, and of La^{140} from Ba^{140} decay are reported along with additional information on Er^{165} and Er^{167} levels obtained from Tm^{165} and Tm^{167} decay. The experimental results are discussed in terms of different nuclear models. (D.C.W.)

4582 (NP-13378) BETA AND GAMMA EMISSION FROM ORIENTED NUCLEI (thesis). Hans Postma (Groningen, Netherlands. Rijksuniversiteit). 1960. 130p.

Theory on beta and gamma emission from oriented nuclei is presented; and measurements of the asymmetry of positron emission from polarized Co^{58} and Mn^{52}, the directional distribution and linear polarization of gamma rays emitted from aligned Ho^{166} and beta emission from oriented Tb^{160} and Ho^{166} are described and discussed. The orientation of the isotopes used and the phenomena of strongly deformed nuclei are also considered. 125 references. (D.C.W.)

4583 (PAN-262) POLARIZATION OF NEUTRONS FROM THE D/d,n/^{3}He REACTION FOR DEUTERON ENERGIES BETWEEN 5.9 AND 11.3 Mev. H. Niewodniczanski, J. Szmider, and J. Szymakowski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). June 1963. 12p.

The polarization of neutrons from the D(d,n)^{3}He reaction for deuteron energies 5.9, 8.6, and 11.3 Mev at a reaction angle of 45° (c.m.) has been measured by means of a coincidence polarization spectrometer with a high-pressure gas scintillation counter. The results seem to remove the sign ambiguity of the polarization. (auth)

4584 (TID-7683(p.21-7)) NUCLEAR PROPERTIES OF PLUTONIUM. Paul R. Fields (Argonne National Lab., Ill.).

A survey is presented of the nuclear properties of Pu. The historical background is discussed briefly. The nuclear properties of Pu are compared with these of other heavy elements. The decay characteristics of the Pu isotopes are considered. (D.L.C.)

4585 (UCRL-8783(Rev.)) NUCLEAR MODELS AND THEIR APPLICATION TO THE HEAVY ELEMENTS. Earl K. Hyde (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1963. Contract W-7405-eng-48. 173p. (CONF-72-6)

From Transplutonium Element Symposium, Argonne, Ill., May 1963.

The unified nuclear model is applied to spherical, deformed, and extremely heavy nuclei in order to clarify the systematics governing the properties (transition rates, parities, vibrational and rotational spectra, wave functions, etc.) of these nuclei. The nuclear shell model is also discussed. (T.F.H.)

4586 (WAPD-T-1626) THE COMPUTATION OF DOPPLER-BROADENED CROSS SECTIONS. E. M. Gelbard (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT(11-1)-Gen-14. 9p. (CONF-187-19)

From American Nuclear Society Meeting, New York, Nov. 1963.

A method is described for calculating Doppler-broadened cross sections for use in resonance escape calculations. The method uses a total differential equation for a particular integral function. A FORTRAN code (DFB) is described that incorporates the method described. The code can be used to tabulate values of the parameters for given ranges of the variables. (T.F.H.)

4587 (AEC-tr-6183) SEARCH FOR H^5 IN THE THERMAL-NEUTRON FISSION PRODUCTS OF U^{235}. V. N. Andreev and S. M. Sirotkin (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki and U.S.S.R. Soviet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). Translated by S. W. O'Rear (Du Pont de Nemours (E. I.) & Co., Savannah River Lab., Aiken, S. C.). 1963. 7p.

An investigation was made of the isotopic composition of the long-range particles emitted during the fission of U^{235} by thermal neutrons. In addition to alpha particles, tritium was found. An upper limit of 2×10^{-5} tritons per fission was found for H^5. This is a significantly lesser yield than the shortest-lived group of delayed neutrons for which H^5 could be the precursor. (auth)

4588 ON THE ALPHA ACTIVITY OF PLATINUM ISOTOPES. Gunnar Graeffe (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, 128: 1-34(1963).

Alpha activity of Pt^{192}, Pt^{190}, Pt^{188}, Pt^{186}, Pt^{184}, Pt^{183}, and Pt^{182} was studied by the ionization chamber technique. The isotope Pt^{190}, which is present in natural platinum, was studied by using both an enriched sample and one of natural platinum. The alpha branching for Pt^{188} was determined on the basis of the level scheme of the decay product Os^{188}. For the other isotopes the alpha branching was determined by assuming that neighboring platinum isotopes are produced in equal abundance in iridium irradiations at sufficiently high proton energy. (auth)

4589 THE KINETIC ENERGY AND THE ANGULAR DISTRIBUTION OF THE NEUTRON- AND PHOTON-INDUCED FISSION FRAGMENTS OF URANIUM-238. B. A. Bochagov, A. P. Komar, and V. I. Fadeev. At. Energy. (USSR), 15: 191-4(Sept. 1963). (In Russian)

A study was made to determine whether the creation of symmetric and asymmetric fission products is or is not due to the same fission mechanism. The factors studied include the excitation energy of the fissioning atom, the yield of the products, the angular distribution, and the effect of the spin state of the component nuclei. Measurements were made to determine the energy and angular distribution of the products resulting from the fission of U^{238} by 14-Mev neutrons and by photons with an E_{max} = 35 Mev, using a double-pulse type ionization chamber. The most probable total kinetic energy at various given mass ratios of the fission products was determined for 5 integrals of the angle between the direction of the emission of the fission products and that of the neutron beam or γ-quanta by recording 3 pulses for each fission. A 150 $\mu g/cm^2$ thick uranyl acetate layer deposited on an aluminized film was used for the tests; a neutron generator and a synchrotron served as the bombarding source. The results indicated that for both symmetric and asymmetric fission product masses the kinetic energy of the products remains unchanged as the angle is varied. From this it is concluded that the rotation energy is small and even though the moments of inertia of the symmetrically and asymmetrically fissioning nuclei are different, this difference does not affect markedly the rotational energy. (TTT)

4590 STUDY OF THE CORRELATION BETWEEN THE MASS DISTRIBUTION OF THE FISSION FRAGMENTS AND THE QUANTUM CHARACTERISTICS OF THE NUCLEUS AT THE SADDLE POINT. P. P. D'yachenko, B. D. Kuz'minov, L. S. Kutsaeva, A. I. Sergachev, and A. N. Utyuzhnikov. At. Energ. (USSR), 15: 246-7(Sept. 1963). (In Russian)

Various characteristics of nuclear fission, such as the energy dependence of the fission cross section, indicate that at the moment of fission the nucleus seems to "remember" the properties it possessed at the saddle point; it may be assumed, therefore, that the mass distribution of the fragments may also conserve the inherent characteristics of the nucleus at that point. The problem was studied on the U^{238} nucleus which possesses a strong maximum at 1.5 Mev in the energy dependence of the angular anisotropy when undergoing fission. The effects of fission due to neutrons at 1.5, 5, 6.5, and 15 Mev were compared, using a 30-microgram per cm^2 thick fissioning layer supported by an organic film. The measurements indicated that in the case of fission of U^{238} by 1.5-Mev neutrons, the quantum characteristics of the nucleus at the saddle point of the angular anisotropy curve do not affect the mass distribution of the fission fragments. (TTT)

4591 RESONANCE LEVELS OF ERBIUM ISOTOPES. M. F. Vlasov, V. P. Vertebnyi, and A. L. Kirilyuk. At. Energ. (USSR), 15: 247-9(Sept. 1963). (In Russian)

The total neutron cross section of Er^{166}, Er^{167}, and of the natural mixture of Er isotopes ($Er^{162,164,166,167,168,170}$) was determined by the time-of-flight method, using a mechanical chopper installed in one of the horizontal beamholes of the VVR-M reactor. The width of the 2.5-mm high slit could be varied from 0.25 to 2.15 mm. The measurements were carried out at 5300 rpm with a channel width of 8 microseconds and a flight path of 18.61 m. Sets of BF_3 filled counters were used as detectors, together with a 256-channel analyzer provided with a ferrite memory. The oxide Er_2O_3 was used for the pure isotope samples and $Er_2(SO_4)_3$ for the specimens made of the natural mixture. The measured level energies and resonance parameters are presented in tabular form. Most of the lower levels were found to belong to the Er^{167} isotope. The data obtained agree with the results reported previously by H. Bjerrum et al (Nucl. Sci. and Engag., 8: 183(1960)). (TTT)

4592 THE ENERGY DISTRIBUTION OF FRAGMENTS RESULTING FROM THE SPONTANEOUS FISSION OF CURIUM-244. L. Z. Malkin, I. D. Alkhazov, A. S. Krivokhatskii, K. A. Petrzhak, and L. M. Belov. At. Energ. (USSR), 15: 249-50(Sept. 1963). (In Russian)

The most probable energy of the light and heavy fission fragments resulting from the spontaneous fission of Cm^{244} was found by A. Smith et al. (Proc. Second Geneva Conf. of the Peaceful Uses of Atomic Energy, (1958) 15: P/690) to be 105.5 and 80 Mev; A. Ghiorso et al. determined the spontaneous-fission half life of this nuclide to be $(1.4 \pm 0.2) \times 10^7$ years (Phys. Rev., 87: 163(1952)). This problem was again investigated and the energy distribution of the fission fragments was determined. A gas scintillation counter was used for measurements that were carried out with a preparation containing 0.243 microgram of Cm^{244}, 0.0058 microgram of Cm^{242}, and less than 0.046 microgram of Pu^{239}. The energy distribution of fragments resulting from the fission of U^{233} by thermal neutrons was used to calibrate the counter. The contribution of the spontaneous fission of Pu^{238} was found to be negligible; that of Cm^{242} was taken into account by means of a suitable correction. On the basis of a spontaneous-fission half life of 7.2×10^6 years, it was found that the most probable values for the energy of the light and heavy fragments resulting from the spontaneous fission of Cm^{244} are (11 ± 4) and (86 ± 3) Mev, respectively. (TTT)

4593 CHANNELING EFFECTS IN THE ENERGY DEPENDENCE OF THE AVERAGE KINETIC ENERGY OF THE FRAGMENTS RESULTING FROM THE FISSION OF

URANIUM-233. V. N. Okolovich and G. N. Smirenkin. At. Energ. (USSR), 15: 250-3(Sept. 1963). (In Russian)

Study of the low-energy fission of U^{235} revealed channeling effects in the energy dependence of the kinetic energy and the excitation energy of the fission fragments at later stages of the reaction. On this basis the dependence of the average kinetic energy of the fission fragments of U^{233} on the energy of the bombarding neutrons was measured by means of an ionization chamber provided with a grid, using 30 microgram/cm^2-thick U^{233} specimens. The layer was placed near the target in order to improve the counting statistics. The measurements were carried out by converting the pulse into a group of standard pulses the number of which was proportional with the amplitude. The ratio of the average pulse amplitudes of fragments resulting from fission by fast and by thermal neutrons was thus determined. Data on the average kinetic energy $\bar{E}_k$, the fission cross section, and the angular anisotropy of the fission of U^{233} indicated that changes of $\bar{E}_k$ at neutron energies beyond 0.5 Mev involve 2 fission channels in the energy ranges of E_n = 0.5 to 0.6 Mev and E_n = 1 Mev; the first channel exceeds E_k by 0.8 Mev, the second by about twice that amount. It was concluded that Fowler's hypothesis on the constancy of $\bar{E}_k$ and the linear relationship between the number of prompt neutrons and $\bar{E}_k$ represent a close approximation; the divergencies are caused by the special characteristics of the fission process. (TTT)

4594 RADIOCHEMICAL STUDY OF THE RARE-EARTH ELEMENT YIELD IN THE CASE OF THE PHOTOFISSION OF URANIUM-238. K. A. Petrzhak and R. V. Sedletskii. At. Energ. (USSR), 15: 308-13(Oct. 1963). (In Russian)

In the photofission of elements heavier than Th, at low excitation levels, heavy and light fragments are obtained; the light group contains the rare earths. In view of the limited amount of information on the photofission of heavy elements, the yields of fragments obtained during the photofission of U^{238} were determined because in that case the indeterminancy of the mass and the charge of the fissioning nucleus is avoided. The maximum energy of the bremsstrahlung at 14 Mev was chosen for the determination of the mass distribution of the fission fragments. The hot-pressed U oxide specimens were irradiated in the betatron of the Leningrad Technical Institute at a maximum electron energy of 15 Mev. The relative yields of La^{141}, Ce^{143}, Pr^{145}, Nd^{147}, Nd^{149}, Pm^{151}, Y^{99}, Ru^{103}, Ru^{105}, Ag^{111}, and Ag^{113} were determined, using Ce^{143} as the standard fission fragment for calibration. The Pm^{149}/Pm^{151} and the Nd^{147}/Nd^{149} ratios were found to be 2.07 ± 0.08 and 1.99 ± 0.06, respectively. The data allowed a curve describing the correlation between the fission fragment yield and the mass number to be plotted. No data were obtained in the mass number ranges from 94 to 103 and 132 to 141. It was found that the masses at the high and low peaks of the groups are reduced and the yields of the symmetric fragments are increased. It may be assumed that the yields of strongly asymmetric masses increase with increasing excitation energy. (TTT)

4595 THE TOTAL KINETIC ENERGY OF THE FISSION PRODUCTS OF URANIUM-233 AND THORIUM-232. S. S. Kovalenko, K. A. Petrzhak, and V. M. Adamov. At. Energ. (USSR), 15: 320-1(Oct. 1963). (In Russian)

The total kinetic energy of fission fragments resulting from the fission of U^{233} and Th^{232} by 14.5-Mev neutrons and of U^{233} by thermal neutrons was measured for fragment ratios of 1, 1.2, 1.3, and 1.43, using a previously described method (Zh. Eksperim. i Teor. Fiz., 42: 1475(1962)); the targets used were 10 and 50 mg/cm^2 thick, respectively. The data obtained indicated the yields of the symmetric fragments and their kinetic energies are related to the changes of the energy of the bombarding particles. It was concluded that the symmetric fission has an adiabatic character; shell effects play a more important role in it than in asymmetric fission. The symmetric process involves less deformation of the nucleus, with resulting increase in the probability of its occurrence and an increased kinetic energy of the fragments. (TTT)

4596 DELAYED NEUTRONS FROM URANIUM-233 IN THE CASE OF ITS FISSION BY 15-Mev NEUTRONS. B. P. Maksyutenko. At. Energ. (USSR), 15: 321-2(Oct. 1963). (In Russian)

A 3.63-g, 30-mm diameter U^{233} specimen was irradiated in a 15-Mev neutron flux and placed on a polyethylene block containing 10 parallel-coupled BF_3-filled counters; simultaneously, the high voltage was turned on. From the total decay curve corresponding to an irradiation of 300 seconds, the relative yields of all the groups were determined at the given half-life values. The thus-derived yield ratio of the first 2 groups was introduced into the equation system of the decay curve corresponding to an irradiation of 30 seconds; this allowed the relative yields of all the groups to be determined. The total yield of the delayed neutrons accompanying the fission of U^{233} by 15.0-Mev neutrons was found to be 1.6 times larger than that of thermal and 3.8-Mev neutrons, amounting to 0.780 ± 0.066 of the total yield of delayed neutrons created by the fissioning of U^{235} by thermal neutrons. (TTT)

4597 DETERMINATION OF THE PARTIAL HALF-LIFE OF THE α-DECAY OF PLUTONIUM-241. R. B. Ivanov, A. S. Krivokhatskii, L. M. Krizhanskii, V. G. Nedovesov, and M. I. Yakunin. At. Energ. (USSR), 15: 322-3(Oct. 1963). (In Russian)

The partial half life, T_α, of the α decay of Pu^{241}, which also undergoes β decay was repeatedly determined but the reported values are widely scattered. An attempt was made to determine this constant. The relative Pu^{241} content of the mixture was derived from mass spectrographic analysis and from α-ionization spectroscopy; the use of an α spectrometer allowed the intensity of the α transition to be measured for each isotope. The half life of the α decay of Pu^{241} was obtained from the relation $T_\alpha = (N_i)/(S_i)$ in which T_α designates the half life of the given isotope, N_i is the ratio of the Pu^{241} atoms to the number of the given isotope, and S_i is the ratio of the α decay of Pu^{241} to that of the given isotope. The average value of T_α was calculated at $(3.9 \pm 0.4) \times 10^5$ years, which agrees well with the data reported by M. Jones et al. (Nuclear Science Abstr. 10: 248 (1956) and of S. Thompson et al. (Phys. Rev. 80: 1108 (1950)). It is estimated that the error does not exceed 25%. (TTT)

4598 FAST-NEUTRON CAPTURE CROSS SECTION VALUES OF COPPER AND ZIRCONIUM. Yu. Ya. Stavisskii and A. V. Shapar'. At. Energ. (USSR), 15: 323(Oct. 1963). (In Russian)

The instantaneous γ-emission method was used for determining the dependence of the radiative capture cross section on the energy of the fast neutrons for the case of natural isotopic mixtures of Cu and Zr. The $T(p,n)He^3$ reaction was used as the neutron source, with a neutron energy scatter of ±16 kev; a CaF_2 scintillation counter was used as the γ detector. The capture cross section curve was obtained by comparing the data with the fission cross section of U^{235}.

The experimental error is estimated at 10% for Cu and 30% for Zr. The absolute cross section values for Cu agree well with the values reported by J. Gibbons et al. (Phys. Rev. 122: 182 (1961)); on the other hand, the corresponding Zr values were found to differ from Gibbons's data. At neutron energies below 200 kev, the average distance between levels is comparable with the energy resolution of the method. The fact that sufficiently thick, 2-cm samples were used for the measurements resulted in a lowering of the capture cross section, due to resonance blocking by scattering. (TTT)

4599 CALCULATION OF THE SPECTRAL-ANGULAR DISTRIBUTION OF SCATTERED γ-QUANTA FROM A MONODIRECTIONAL CESIUM-137 SOURCE IN IRON. L. P. Kimel', A. M. Panchenko, and V. P. Terent'ev. At. Energ. (USSR), 15: 328-31(Oct. 1963). (In Russian)

The Monte Carlo method was used for calculating the spectral and angular distribution of the scattered energy of γ quanta, emitted with an initial energy of 0.661 Mev by a Cs^{137} point source placed in an infinite Fe medium. The 5420 measurements were carried out by determining the path of the quanta up to the first interaction, determining the type of the interaction, and calculating the energy of the scattered γ quantum by the Compton effect; at the same time the direction of the flight path after scattering was also determined. The measurements were repeated until the quantum disappeared as the result of the photoeffect or because of transition to an energy level below 10 kev. Angular integration of the scattered radiation spectra showed that the energy of the quanta is limited within 0.13 to 0.26 Mev. The data obtained made it possible to calculate the buildup factor B_E of a flat, monodirectional source. (TTT)

4600 NUCLEAR ENERGY. WHAT IT IS AND HOW IT ACTS. PART 12. Andrew W. Kramer. Atomics, 16: No. 6, 50-6(Nov.-Dec. 1963).

The role of the neutron in nuclear reactions, resonance effects, the basis for the high neutron cross section of cadmium, and the Breit-Wigner theory of neutron cross sections are considered. (H.M.G.)

4601 EMISSION OF FAST FRAGMENTS OF CHARGE 2 IN HIGH-ENERGY NUCLEAR INTERACTIONS. Bernard Tinland, Françoise Bartholin, and Adèle Burdet (Institut de Physique Nucléaire, Lyon). J. Phys., 24: 604-10(Aug. 1963). (In French)

Particles of charge 2 emitted with an energy between 200 and 600 Mev in the interactions of 22-Bev protons with emulsion nuclei are studied. The results give the cross section, energy, and angular spectra, and show that such particles are most frequently emitted in many-pronged stars. A theoretical explanation of the production of these particles is suggested. (auth)

4602 RELATIVE GAMMA INTENSITIES AND K-SHELL CONVERSION COEFFICIENTS OF SOME TRANSITIONS IN U^{233}. Alceu de Pinho and Roger Foucher (Institut du Radium, Orsay, France). J. Phys., 24: 638-40(Aug. 1963). (In French)

The intensities, K conversion coefficients, and multipolarities of gamma lines of U^{233} between 271.6 and 415.6 kev were measured by means of a scintillation-detector assembly. The experimental results are compared with theoretical predictions and other experimental findings in order to determine the accuracy of the scintillation method. (T.F.H.)

4603 THE EFFECT OF SHELL CLOSURE OF THE ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED PARTICLES. A. E. Forest (Nuclear Physics Lab., Oxford). Phys. Letters, 7: 130-1(Nov. 1, 1963).

An optical model is used in investigations of the diffraction oscillation anomaly in 11.8-Mev deuteron scattering cross sections for nuclei of Z = 45 to 52. The calculations confirm the behavior as being caused by the variation of the absorbing potential near the closed shell Z = 50 in Sn. (R.E.U.)

4604 POSSIBLE VARIATION OF THE COUPLING SCHEME WITH RADIUS IN A LIGHT NUCLEUS. A. B. Clegg (Nuclear Physics Lab., Oxford). Phys. Letters, 7: 132-3(Nov. 1, 1963).

The probability of spin-flipping in the inelastic scattering of nucleons in the fringe of the C^{12} nucleus is discussed. A comparison between studies of the states of B^{11} and C^{11} produced when a nucleon is knocked out of C^{12} by a nucleon of 120 to 150 Mev and in the $C^{12}(p,d)$ reaction at 154.5 Mev, respectively, indicates that the difference in knockout and (p,d) reactions can be explained by the large difference in momentum transfer. The absorption of outgoing waves in the two reactions also contributes to the difference. (R.E.U.)

4605 ENERGIES OF $f_{\frac{7}{2}}$-SHELL NUCLEI. J. N. Ginocchio and J. B. French (Univ. of Rochester, N. Y. and Oak Ridge National Lab., Tenn.). Phys. Letters, 7: 137-9(Nov. 1, 1963).

A theoretical study of the properties of $f_{\frac{7}{2}}$-shell nuclei is presented. The binding energies and spectra of nuclei of Z = 22 to 28 are given. The contribution to the binding energies by the residual two-body interaction is considered. (R.E.U.)

4606 NUCLEON CLUSTERING AND THE SHELL-MODEL. V. E. Bunakov (Leningrad State Univ.). Phys. Letters, 7: 140-1(Nov. 1, 1963).

The connection between the nucleon clustering and the form of shell-model wave functions is discussed. Clustering is taken into account by effective two-body interactions in the framework of the independent-particle model. Results are given for some Z = 3 to 13 nuclei. An experimental binding energy law is given that is applicable to A ≅ 30 nuclei. (R.E.U.)

4607 POSSIBLE ISOMERIC TRANSITION IN THE ISOTOPE Al^{30}. E. Peeters (Université Libre, Brussels). Phys. Letters, 7: 142-4(Nov. 1, 1963).

Silicon was bombarded by 14-Mev neutrons, and a resulting gamma activity was found with energies of 2.5 and 3.5 Mev and a half life of 72.5 sec. The activity is concluded to be an isomeric state of Al^{30} and is shown in a Si^{30} energy level scheme. The cross section for the reaction $Si^{30}(n,p)Al^{30m}$ was found to be 0.18 ± 0.06 b. (R.E.U.)

4608 ON THE HOLE-PARTICLE INTERACTIONS IN LIGHT NUCLEI. H. Horie and T. Yokozawa (Tokyo Inst. of Tech.). Phys. Letters, 7: 145-6(Nov. 1, 1963).

The low-lying excited states of doubly closed-shell calcium-40 are accounted for by employing the L-S coupling shell model with the SU(3) classification. (R.E.U.)

4609 BEHAVIOR STATISTICS ON THE REACTION $Al^{27}(d,\alpha)Mg^{25}$ BETWEEN 2 AND 10 Mev. Y. Cassagnou, I. Iori, C. Levi, T. Mayer-Kuckuk, M. Mermaz, and L. Papineau (CEN, Saclay, France). Phys. Letters, 7: 147-9(Nov. 1, 1963). (In French)

The excitation functions for the reaction $Al^{27}(d,\alpha)$ are measured at deuteron energies of 2 to 10 Mev. Separate excitation functions are determined for the first five alpha groups. The experimental results are compared with

statistical-model calculations in which the summations over all the residual-nucleus states are replaced by a particular integral. The experimental and theoretical excitation functions are in agreement. (T.F.H.)

4610 MEASUREMENT OF THE POLARIZATION OF POSITRONS EMITTED IN THE DISINTEGRATION OF Na^{22}, B^8, AND μ^+. L. Dick, L. Feuvrais, and M. Spighel (CERN, Geneva). Phys. Letters, 7: 150-3(Nov. 1, 1963). (In French)

Asymmetries and polarizations in the positron emission in beta decay of B^8, Na^{22}, and μ^+ mesons are measured. (T.F.H.)

4611 NUCLEAR PHOTODISINTEGRATION OF THE THREE-BODY SYSTEM. P. O. Davey and H. S. Valk (Univ. of Nebraska, Lincoln). Phys. Letters, 7: 155-6 (Nov. 1, 1963).

The electric dipole bremsstrahlung weighted cross section and the integrated cross section are calculated using a potential that includes both a repulsive core and tensor force component. Experimental and theoretical values are given for H^3 and He^3. (R.E.U.)

4612 CHARGE DEPENDENCE OF NUCLEAR FORCES AND ENERGY DIFFERENCES IN THE A = 14 ISOBARIC SPIN TRIPLET. R. J. Blin-Stoyle and S. C. K. Nair (Univ. of Sussex, Brighton, Eng.). Phys. Letters, 7: 161-2(Nov. 1, 1963).

An order of magnitude estimate is made of Coulomb energy differences for the A = 14 isobaric spin triplet and the sensitivity of the difference to correlations in the assumed nuclear wave function. The Coulomb energy difference effects on the charge dependence of nuclear (short range) forces are discussed. (R.E.U.)

4613 REACTIONS INDUCED BY 155 Mev PROTONS ON LIGHT NUCLEI. L. Valentin, G. Albouy, J. P. Cohen, and M. Gusakow (Institut du Radium, Orsay, France). Phys. Letters, 7: 163-4(Nov. 1, 1963). (In French)

Characteristics of (p,n), (p,p2n), (p,α), (p,2n), (p,αn), (p,pαn), (p,4p4n), (p,pn), (p,3p4n), (p,5p5n), (p,2p3n), (p,2p4n), (p,4p5n), (p,4p6n), and (p,6p7n) are studied on the nuclei Li^7, Be^9, B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, and F^{19}. (T.F.H.)

4614 CONCURRENCE BETWEEN DIRECT INTERACTIONS AND PROCESSES TAKING PLACE THROUGH A COMPOUND NUCLEUS. S. Ishida. Stroenie Yadra, Sb., 139-42(1962).

The competition between direct processes and compound nuclear processes is discussed briefly. The reaction amplitude is represented as the sum of the amplitudes corresponding to direct and resonance processes. Formation of a compound nucleus affects the reaction process in 2 ways. First, the presence of resonance leads to specific distortions in the wave functions, changing the component corresponding to the direct process. Second, interference arises between the resonance and nonresonance components in the amplitude. There are indications that the 1st effect is negligibly small while the 2nd is important. The interference term should vanish if the cross section is averaged in an energy interval containing a large number of resonances. (Ref. Zh., Fiz. 1963).

4615 DIFFRACTION OF X RAYS BY LIQUIDS—NITROGEN, OXYGEN, AND THEIR MIXTURES. Horace Wataru Furumoto. Thesis, Columbus, Ohio, Ohio State Univ., 1963. 150p.

The x-ray scattering patterns of liquid nitrogen and liquid oxygen were measured at 77 and 64°K at the saturated vapor pressures of the liquids. The x-ray scattering patterns of three mixtures of nitrogen and oxygen liquids of approximate compositions 20/80, 50/50, and 80/20 were observed at the saturated vapor pressures of the mixtures at 77°K. A LiF crystal monochromatized the radiation from a molybdenum x-ray tube at the K alpha line. A scintillation detector detected the beam scattered by the samples; the range of observation of the detector was 0.02 to 1.00 A^{-1} in $\sin\theta/\lambda$. The atomic and electronic distribution functions for the samples were obtained from the x-ray diffraction patterns by means of the Fourier inversion process. The effect resulting from the finite termination of the Fourier integral for the specific case of scattering from bonded atoms was examined in detail. The atomic distribution functions for liquid oxygen at 77 and 64°K did not show evidence of O_4 molecules. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4616 AN ANALYSIS OF THE REACTION $B^{10}(d,p_1)B^{11*}$ (2.14 Mev). Frank Samuel Levin. Thesis, College Park, Md., Univ. of Maryland, 1961. 197p.

A theoretical investigation of the angular distribution of protons from the reaction $B^{10}(d,p_1)B^{11*}$ was made. An analysis of the available experimental data indicated that the angular momentum selection rule of the Butler theory of deuteron stripping is violated in this reaction. Thus, the Butler theory cannot account for the behavior of the observed angular distributions nor can the final state interaction of the captured neutron and outgoing proton, used in the Butler theory, be the mechanism by which the reaction proceeds. The direct nuclear reaction theory was used as a framework for studying the other possible reaction mechanisms. The other mechanisms give rise to three different types of scattering amplitudes: the knock out amplitude, the heavy particle stripping amplitude, and the proton target amplitude. The first two amplitudes arise from exchange effects due to inclusion of the Pauli principle. Angular distributions are calculated for each case using the approximations of plane waves for the relative motion in the initial and final states and j-j coupling for the nuclear states. Single particle states are represented by harmonic oscillator wave functions. A calculation of the proton target angular distribution was made using a real deuteron and Bhatia approximations. Agreement with the experimental data at 8.1 Mev was not obtained. The ratio of the maxima occurring in the proton target and heavy particle stripping cross sections was found to be about 100. Distortion effects are then included in the calculation using an approximate method developed by Rodberg. Use of distortion greatly improves the fit to the data. It was concluded that the reaction mechanism is the proton target interaction; distortion effects are important in the reaction; and the structure in the observed angular distribution near 90° is an effect of the finite deuteron size. Several appendices are included in which the scattering amplitude is derived and then antisymmetrized. It is shown that both the initial and the final states must be antisymmetrized to obtain the proper normalization of the transition operator. (TCO)

4617 THE STOPPING CROSS SECTIONS OF HYDROCARBON GASES. John Thornton Park. Thesis, Lincoln, Neb., Univ. of Nebraska, 1963. 134p.

The stopping cross sections of air, helium, acetylene, cyclopropane, ethylene, methane, propane, and propylene were measured for proton energies 40 to 240 kev. The stopping cross sections of ethylene and propane were measured for helium ions. The standard deviations of the measurements vary between 1.5 and 4%. The failure of the Bragg rule of additivity for the stopping cross sections of

hydrocarbon vapors for proton energies of less than 150 kev was clearly illustrated both by a general analysis of the data and by consideration of the stopping cross sections of propylene and cyclopropane, which have the same chemical constituents. The stopping cross sections of the hydrocarbon gases for protons were in agreement with a previously proposed additivity rule and give further indications of its validity. Using this rule the stopping cross sections of electrons in the various chemical bonds were calculated from the measured molecular stopping cross sections. These electron cross sections permit the calculations of stopping cross sections for other organic compounds with an accuracy which, in most cases, is comparable with the accuracy of the measured cross sections. Comparison of helium ion and proton stopping cross sections of solids and vapors revealed interesting features that may reflect either differences in the stopping characteristics of solids and vapors, or stopping effects of chemical binding that depend on the incident ion. The helium ion stopping cross sections also indicate that the effect of chemical binding on stopping cross sections is unlikely to be any greater for incident helium ions than for incident protons at the same energy. (TCO)

4618 INTERPRETATION OF COMPLEX NUCLEAR MAGNETIC RESONANCE SPECTRA. Robert Charles Hirst. Thesis, Salt Lake City, Univ. of Utah, 1963.

The features of certain classes of A_2B_2 spectra were investigated systematically relative to the parameter involved, and the characteristic spectra are given as an aid to future interpretation. The effects upon the spectra of the relative signs of the coupling constants are discussed. Examples are provided by the analysis of the spectra of furan, thiophene, three symmetrical ortho disubstituted benzenes, two nonsymmetrical para disubstituted benzenes, one symmetrical p,p′-disubstituted biphenyl, and one nonsymmetrical 1,2-disubstituted ethane. Better resolution than was obtainable in previous studies permitted a more detailed analysis for compounds cited earlier. In many examples the 24 main spectral lines expected for four spin systems of this symmetry were observed. It was found that all four of the H-H coupling constants are of the same sign in thiophene, and $J_{\alpha\beta}$ and $J_{\alpha\beta}'$ are of the same sign in furan. Appreciably different values, 1.55 and 2.85 cps, for $J_{\alpha\alpha}$, and 1.8 and 4.7 cps, for $J_{\alpha\beta}$, are found in furan and thiophene, respectively. On the other hand, $J_{\beta\beta}$ and $J_{\alpha\beta}'$ are virtually identical with values of 3.53 and 3.35 cps, and 0.8 and 1.0 cps, respectively, in furan and thiophene. In the substituted benzenes, the values found for J_o, J_m, and J_p fall in the ranges 7.4 to 8.8 (9), 1.24 to 3.05 (9), and 0.3 to 0.6 cps (6), the number of cases being given in parentheses. The disubstituted benzenes studied have two nonequivalent ortho or meta coupling constants. They are found to differ by as much as 0.6 cps. In each of the substituted benzenes it was found that all of the couplings are of the same sign. It is shown that for certain values of the chemical shift, it is possible to determine magnitudes and signs of all the couplings, and the 60 Mcs spectrum of 2-bromoethanol was analyzed as an example. In this case $K = J_A + J_B$ is of opposite sign from $N = J + J'$. The use of effective frequencies in the analysis of spectra in which a group of n magnetically equivalent nuclei, X_n, interact with various strongly coupled groups (AB_2, A_2B_2, and ABC) was discussed. It is shown that the spectrum of the strongly coupled group may be analyzed in terms of n + 1 subspectra of the same symmetry and the same coupling constants but with different effective chemical shifts. The X spectrum may have asymmetry under certain conditions (described under the analysis of the various specific groupings). When experimentally resolvable asymmetry is present, it is possible to relate the signs of the couplings to the X group to the signs of the couplings in the strongly coupled group (except for ABX_n). For an example of the analysis of AB_2X_n spectra, the spectrum of methyl allene was analyzed as an AB_2X_3 case. The spectrum of 1-chloro-2, 3-butadiene was analyzed as an AB_2C_2 system in which the C_2 hydrogens were sufficiently removed from the AB_2 region that the spectrum could be studied as a "perturbed" AB_2X_2 system. It was found that in each molecule the couplings through three and five bonds (J_{AX} and J_{BX}, respectively) were of opposite sign from J_{AB}, the coupling through four bonds. In the study of A_2B_2X spectra, the conditions under which the signs of J_{AX} and J_{BX} could be related to the signs of the couplings in the A_2B_2 group were discussed for the first time. It was shown that all couplings in p-fluoroanisole are of the same sign and that $J_o^{HF} > J_m^{HF}$. As examples of the $ABCX_n$ spectra, acrolein and vinyl acetylene were studied for n = 1, and a allyl cyanide, allyl isothiocyanate, and allyl sulfide were studied for n = 2. In the five different vinyl groups, the couplings lie in the following ranges: J_{cis} = 9.97 to 11.50 cps; J_{trans} = 16.80 to 17.35 cps; and J_{gem} = 0.82 to 2.05 cps. In the allyl compounds, the value of J_{AX} (the coupling between the methylene group and the adjacent vinyl hydrogen) varies from 4.90 to 7.15 cps, while both J_{BX} and J_{CX} have values in the range −0.90 to −1.90 cps. (TCO)

4619 POLARIZATION STUDIES OF (d,p) REACTIONS. Robert Woods Bercaw. Thesis, St. Louis, Washington Univ., 1962. 113p.

The polarizations of protons produced by the $Be^9(d,p)Be^{10}$, $B^{10}(d,p)B^{11}$, $Si^{28}(d,p)Si^{29}$, and $Ca^{40}(d,p)Ca^{41}$ reactions, initiated by 10-Mev deuterons, were measured in order to investigate the nature of deuteron stripping reactions. The polarizations were measured by scattering the protons from a carbon target and comparing the number scattered to the right side of the incident proton beam with the number scattered to the left. Using the known parameter P_2, of the proton-carbon scattering process, the polarization of the protons, P_1, was determined from the relation $P_1 P_2 = (N_R - N_L)/(N_R + N_L)$ where N_R and N_L are the numbers of protons recorded by identical counter telescopes placed on the right and left hand sides of the carbon scatterer (the polarization P_1 is defined as positive when it is along $\vec{k}_d \times \vec{k}_p$). Each counter telescope consisted of a scintillation counter, whose output was sorted by pulse height to distinguish between protons coming from different energy levels of the final nucleus, and a proportional counter placed between the scintillation counter and the carbon scatterer. Background was reduced to a negligible amount by requiring a coincidence between the two counters before recording an event as a scattered proton. The measured polarizations were compared with the various forms of the Born approximation theory and found to be in disagreement with its simplest form, the central potential DWBA. More sophisticated forms, containing spin-dependent potentials, were developed only for reactions where the neutron is captured into an s-orbital ($l = 0$) in the final nucleus (the central potential DWBA predicts $P_1 = 0$). The $Si^{28}(d,p)Si^{29}$ polarizations, a reaction characterized by $l = 0$, were found to be in qualitative agreement with the theory. (TCO)

4620 DECAY STUDIES OF SILVER ISOTOPES OF MASSES 115, 116, AND 117. Emil Lawrence Bahn, Jr. Thesis, St. Louis, Washington Univ., 1962. 129p.

In the study of radiations from Ag^{115} nuclei, 19 gamma rays were observed with the following energies in Mev

(and intensities in percent of Ag^{115} ground-state decays): 0.13(6.0), 0.22(35), 0.30(6.0), 0.36(8.3), 0.47(14.3), 0.55(4.6), 0.64(15.7), 0.71(4.0), 0.77(1.3), 0.99(1.3), 1.11(1.7), 1.18(1.3), 1.38(2.0), 1.47(3.4), 1.66(3.7), 1.83(5.0), 1.92(6.0), 2.15(9.4), and 2.30(1.3). The data were obtained from single-crystal and gamma-gamma coincidence spectra and with NaI(Tl) scintillation detectors. The single-crystal spectra were corrected experimentally for gamma ray summing, and for bremsstrahlung effects. Gamma-gamma coincidence spectra were measured with gating energies of 0.13, 0.22, 0.30, 0.36, 0.47, 0.64, 1.47, 1.66, 1.83, 1.92, and 2.15 Mev; Hoogenboom spectra were measured using gamma-ray sum gating energies of 2.15, 0.37, and 0.52 Mev. A decay scheme is proposed for Ag^{115}, postulating existence of a short-lived (~ 1.5-minute) Ag^{115} ground state, of which the activity in the above measurements was in secular equilibrium with the 20-minute Ag^{115} activity, now attributed to an isomeric state. 9% of the 20-minute Ag^{115} isomer decays directly (by beta-decay) to the isomeric-state of Cd^{115} while 91% undergoes isomeric transition to the 1.5-minute Ag^{115}. The results of preliminary studies of the decay properties of Ag^{116}, indicate a half life of 2.5 ± 0.1 minutes, and emission of 13 gamma rays. The latter have the following energies in Mev (and intensities in percent of Ag^{116} decays): 0.51(25), 0.60(?), 0.71(20), 0.9(?), 1.0(11), 1.2(10), 1.4(?), 1.5(?), 1.76(31), 2.0(7), 2.2(8), 2.5(17), and 2.6(18). Spectral measurements together with the single crystal beta-radiation data (corrected for backscattering) when examined via Kurie analysis, disclosed beta-rays with the following end-point energies in Mev (and intensities in percent of Ag^{116} decay): 5.12(9), 3.41(21), 2.58(26), 2.26(33), and 1.30(11). A proposed preliminary decay scheme is consistent with these results. Ag^{117} was identified as a shorter-lived component of 0.7 ± 0.2 minutes half life in the various decay measurements made to determine the half life for Ag^{116}. (TCO)

4621 COLLECTIVE EFFECTS IN DIRECT INTERACTION PROCESSES. Harry Conrad Meyer. Thesis, Nashville, Vanderbilt Univ., 1963. 115p.

The theory for a (d,p) stripping reaction is presented. The angular distribution of the reaction $Be^9(d,p)Be^{10}$ for stripping to the first excited level of the residual nucleus is evaluated as an example of configuration mixing effects and found to have, in addition to the $\ell = 1$ contribution permitted by the shell model, an $\ell = 3$ contribution, which gives an improved fit to the data. The (p,γ) angular correlation function for this reaction is investigated. Configuration mixing introduces a $P_4(\cos\theta_{p\gamma})$ term in this correlation function in addition to the $P_2(\cos\theta_{p\gamma})$ term allowed by the shell model. The data can be fitted best by inclusion of such an additional term. The effect of configuration mixing for the inelastic scattering of protons on C^{12} is also considered. The direct-interaction inelastic scattering theory for this process is discussed. The spin-independent and spin-dependent matrix elements for this process are evaluated. The admixtures of higher configurations give a quite large enhancement for the spin-independent matrix element but a large inhibition for the spin-dependent matrix element. This configuration mixing then gives an increase in the magnitude of the scattering cross section, which leads to better agreement with experiment. (TCO)

4622 A VARIATIONAL PROCEDURE FOR HARD CORE POTENTIAL. Yoon Suk Koh. Thesis, Lincoln, Neb., Univ. of Nebraska, 1963. 81p.

A set of variational calculations was carried out with suitable trial wave functions constructed to conform with the features and boundary conditions imposed by the hard core. The form of the trial function is suggested by perturbation theory and it is rather straightforward so that it can be used in complicated problems. The method was justified for the cases without hard core such as Mathieu's Equation and the harmonic oscillator, and the eigenvalues in the former case are improved by this method over results obtained by refined perturbation procedures. The harmonic oscillators with an infinitely repulsive region of various radii were considered to test the procedure and to see the variation of energy with the core radius. The problem was solved approximately by two other methods, numerical integration and perturbation theory. The three results were found to agree to at least two significant digits in the eigenvalues for the largest size of core, and the latter two agree to the first three digits. Finally the procedure is applied to the deuteron with the Brueckner-Gammel potential, resulting in a fairly good approximation in both binding energy and the wave function. In this case again the second order variational calculations yield binding energy with an accuracy of at least two significant digits. (Dissertation Abstr., 24: No. 4, Oct. 1963.)

4623 EIGENSTATES OF ASYMMETRIC ODD-A ATOMIC NUCLEI. Benjamin Exner Chi. Thesis, Troy, N. Y., Rensselaer Polytechnic Inst., 1962. 147p.

A description of the properties of nuclides with odd mass-number A is given within the framework of the collective model. All the nucleons except one are presumed to undergo a collective behavior being the quantum-mechanical analog of a rotating liquid drop of fixed ellipsoidal shape. From these nucleons arises a collective potential well under whose influence moves the last nucleon. The potential well also has ellipsoidal shape. The Hamiltonian for the entire system is diagonalized exactly, in contrast to earlier treatments where the collective core and the last nucleon are treated separately. The calculation is done with high-speed computers. The model is applied to nuclides in the range $17 \leq A \leq 39$ corresponding to the (2s-1d) shell of the Mayer-Jensen shell model. Energy eigenvalues and eigenvectors are obtained for several specific nuclides in this region and with the latter, electromagnetic moments and transitions are determined. Agreement with the experimental energy levels is, on the whole, very good, considering the relative simplicity of the description. In every case at least the order of low-lying levels is correct though the agreement is more often quantitative. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4624 MUON CAPTURE IN HELIUM-3. Richard L. Wagner, Jr. Thesis, Salt Lake City, Univ. of Utah, 1963. 86p.

Negative muons were stopped in a He^3 gas scintillation counter, and the rate of the interaction $\mu^- + He^3 \rightarrow H^3 + \nu$ was measured, where the produced H^3 nucleus is in the ground state. The interaction was identified by the characteristic 1.9 Mev pulse produced in the He^3 scintillant by the monoenergic recoil tritium nucleus. Decay electrons from the competing muon decay process were counted in a xenon gas scintillation counter that surrounded the cubical He^3 target on 5 sides. The efficiency of electron detection was measured directly. The counters were constructed almost entirely of materials with high atomic number, and muon interactions in the materials were distinguished by their characteristic short muon-disappearance mean lives. Contamination of the data by muons stopping in residual low-Z material was evaluated by replacing the He^3 in the target counter with xenon, so that the only counts exhibiting a long mean-life were due to that contamination. The

capture rate was found from the ratio of the number of captures to the number of decays times the known decay rate. The result for the capture rate to the ground state is $(gnd/c) = (1.48 \pm 0.29/0.27) \times 10^3\ sec^{-1}$. This result is in agreement with theoretical calculations based on the universality of the V-A Fermi interaction and the validity of the Feynman–Gell-Mann conserved vector current hypothesis. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4625 ABSOLUTE DIFFERENTIAL CROSS SECTIONS FOR PHOTOPRODUCTION OF LOW ENERGY POSITIVE PIONS FROM HYDROGEN. Ronald James Walker. Thesis, Lafayette, Ind., Purdue Univ., 1963. 116p.

The absolute differential cross section was determined for the photoproduction of positive pions from hydrogen with the laboratory pion kinetic energy fixed at 33.8 Mev for each of eight angles between 22 and 135°. A polyethylene-carbon subtraction method was used. Systematic errors were minimized by an extensive calibration of the space and momentum variation of the solid angle of acceptance of the 120 degree double focusing magnetic spectrometer which was used to momentum analyze the pions, a measure of the beam intensity distribution, and an experimental determination of both the contamination by positive muons and the effects of multiple scattering. Angle dependent systematic errors were virtually eliminated by fixing the pion energy and by adjusting the peak bremsstrahlung energy so that 15% of the energy spectrum of photons was above the energy of the photon producing the observed meson at each angle. The systematic accuracy is believed to be 4%, while the counting statistics were 3%. (TCO)

4626 ELECTROMAGNETIC MULTIPOLE MOMENTS OF DEFORMED ATOMIC NUCLEI. Stanley A. Williams. Thesis, Troy, N. Y., Rensselaer Polytechnic Inst., 1962. 134p.

Electric and magnetic multipole operators were developed and their matrix elements calculated for three current models that describe deformed, odd-A nuclei. These are the axially symmetric hydrodynamic model, the asymmetric hydrodynamic model and the elastic ellipsoid model. The range of model validity is $17 \leq A \leq 40$, $150 \leq A \leq 180$, and $A \geq 220$, where A is the mass number. A predictive table of magnetic octupole moments is given for those nuclei with ground state spins greater than or equal to three-halves which can be incorporated within the schemes of the models. With but two exceptions the predicted moments are of the same magnitude as, or larger than, the moments measured for seven nuclei. For the axially symmetric hydrodynamic case the model parameters were determined by fitting the measured values of the lower moments and transition probabilities. The assumption was made that the orbital gyromagnetic ratio for the odd nucleon is that of a free particle. From the total gyromagnetic ratio of the odd nucleon the spin gyromagnetic ratio, g_s, was determined. With but one exception g_s was found to have a value between the free particle and Dirac particle values. For the asymmetric hydrodynamic model, g_s was again taken as a fitting parameter, but all the other model parameters were taken as given from energy level considerations. For the elastic ellipsoid model the parameters that were obtained by fitting the lower moments were used. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4627 METODY ISSLEDOVANIYA IZLUCHENIYA YADER PRI RADIATSIONNOM ZAKHVATE TEPLOVYKH NEITRONOV. (Investigation of Nuclear Emissions in Thermal Neutron Radiative Capture). A. M. Demidov. Moscow, Gosatomizdat, 1963. 75p.

Descriptions are given of devices and measuring methods for nuclear emissions in radiative capture of thermal neutrons. Gamma spectrum measurements with magnetic and diffraction spectrometers and measurements of internal conversion electron spectra, internal conversion pair spectra, internal conversion pair spectra, and γ spectra with NaI(Tl) crystal spectrometers are discussed, as well as measurements of γ-γ coincidences, angular correlations, and e-γ and e-e coincidences. (R.V.J.)

4628 TEORIYA PRYAMYKH YADERNYKH REAKTSII. (The Theory of Direct Nuclear Reactions). I. S. Shapiro. Moscow, Gosatomizdat, 1963. 92p.

A compact presentation is given on the concept of direct nuclear reaction theory. The direct process dispersions theory and Feynman amplitude diagrams are discussed. The presence of to-and-fro anisotropy in the center-of-inertia system and the position and properties of direct reaction amplitudes according to q^2 are analyzed, and formulas are developed for the simplest Feynman diagrams expressed by a virtual disintegration (synthesis). Effects related to finite nuclear dimensions are considered, and complex reactions in which the number of finite products is more than two (a particle knockout from nuclei and slow μ^-, π^-, and K^- capture) are analyzed. Diagrams of initial and finite state reactions and Omnes and Muskhelishvili integral equations and their solutions are given. (R.V.J.)

4629 TIME DELAY IN NUCLEAR REACTIONS. D. M. Brink (Univ. of Oxford). 12p. (CONF-327-6).

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

Nuclear reactions at intermediate energies (~10 Mev) are characterized by fluctuations in cross section as a function of energy. The correlation energy of the fluctuations is related to the lifetime of the compound nucleus and it is shown that the correlation function determines the time delay of the compound nucleus component in a nuclear reaction. (R.E.U.)

4630 AN INTERPRETATION OF THE ANGULAR DISTRIBUTIONS OF THE γ RAYS IN THE REACTION $[Li^7(p,\gamma)Be^8]$. D. J. Schlueter, F. W. Prosser, Jr., and R. W. Krone (Univ. of Kansas, Lawrence). 11p. (CONF-327-1)

From Topical Conference on Compound Nuclear States, Gatlinburg, Tenn., Oct. 1963.

Angular distributions were measured from 800 to 1700 kev with a NaI detector and recorded on a multichannel analyzer in an attempt to give unique spin and parity assignments to the 441- and 1030-kev resonances. No acceptable agreement was found for a 1^- assignment for the 1030-kw resonance and any combination of higher state spins and parities. (R.E.U.)

4631 THE ANGULAR CROSS-CORRELATION FUNCTION OF NUCLEAR CROSS-SECTION FLUCTUATIONS. D. M. Brink (Univ. of Oxford), R. O. Stephen, and N. W. Tanner. 22p. (CONF-327-5)

From Topical Conference on Compound Nuclear States, Gatlinburg, Tenn., Oct. 1963.

Fluctuations in nuclear differential cross sections as a function of energy are studied for intermediate energies (~10 Mev). The fluctuations of angular distribution and of intensity at a particular angle are found to be uncorrelated if the energy of the incident particle is changed by an amount large compared to width of the fluctuation. The cross-correlation of intensity fluctuations at two angles is considered. (R.E.U.)

4632 COMPOUND NUCLEAR SHELL EFFECTS IN 14 Mev (n,α) REACTIONS. A. Chatterjee (Saha Inst. of Nuclear Physics, Calcutta). 16p. (CONF-327-2)

From Topical Conference on Compound Nuclear States, Gatlinburg, Tenn., Oct. 1963.

A compilation of 14-Mev (n,α) reaction cross sections shows that in a few regions no measurements exist, that most regions lack in precision, and that the variation with energy around 14 Mev is small. With a judicious selection of data (using most abundant target elements) smoothed curves reveal distinct shell effects. The cross section dips down at the proton shell and sub-shell closure positions throughout the mass region. Within a shell, the odd-even nucleon effects disappear and the cross section is a very slowly decreasing function of the mass number. Across the shells, in addition to abrupt discontinuities, there is a gradual decrease of the cross sections from smaller to larger shells. These effects can be compared with various recent statements of the statistical level density. Good agreement with the assumption of the validity of the compound nuclear reaction at high excitation can be obtained. Particularly illustrative in this respect is the agreement with the background effects, odd-even effects, structure effects, and isomeric cross sections. (auth)

Plasma Physics and Thermonuclear Processes

4633 (AD-299998) RADIATION FROM A UNIFORMLY MOVING CHARGE IN AN ANISOTROPIC PLASMA. Technical Report No. 389. H. S. Tuan and S. R. Seshadri (Harvard Univ., Cambridge, Mass. Cruft Lab.). Dec. 26, 1962. Contract Nonr-1866(32). 29p.

The radiation from a point charge moving uniformly in a plasma is investigated when the charge is moving in the direction of an external magnetic field. In general, there are two modes, for each of which all the components of the electric and magnetic field are present. The two parameters of interest in this problem are the ratio of the velocity of the charges to the free-space velocity of electromagnetic waves, and the ratio of the gyromagnetic frequency to the plasma frequency of the electrons. For two sets of values of these parameters, the frequency and the angular spectrum of the emitted radiation are obtained. In certain cases, as many as three Cherenkov rays are found to propagate in the same direction; these multiple rays, however, correspond to different frequency components and to different modes of propagation. The motivation for this investigation is indicated briefly. (auth)

4634 (LADC-5356) THE INVESTIGATION OF THE HIGH-ENERGY ACCELERATION MODE IN THE COAXIAL GUN. J. W. Mather (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 27p.

The amount of deuterium gas admitted to a short-center-electrode (1 cm) coaxial plasma gun delineates two regions of operation, depending on whether the gas is localized near the inlet port or allowed to diffuse throughout the gun length. In the former case, fast deuterium ions with energy in excess of the applied voltage (V_0 = 15 kv) emerge from the gun muzzle whereas in the latter, the accelerated plasma (which initially starts at the breech end) reaches an axial velocity of $\sim 2.5 \times 10^7$ cm/sec at the muzzle end and forms a high density plasma focus on the axis in front of the central electrode. Neutron measurements show that this dense plasma is not in contact with the electrode and is most probably stagnated by the high ambient gas pressure downstream. Particle momentum analysis of the fast-ion ($>V_0$) distribution and neutron measurements downstream of the gun suggest two accelerated groups of fast ions: a group of $\sim 10^{16}$ particles, which diverge from the gun muzzle; and a group of $\sim 10^{14}$ particles, which streams primarily along the axis with a radial distribution of ~3 cm width. Multiple probes show an asymmetric angular distribution of the discharge current that varies as a function of time during a given discharge. A sharp break in the total gas current is accompanied by large inductive voltages. In the high-energy mode, inductive voltages up to $7 \times V_0$ are recorded at the breech end. (auth)

4635 (MATT-196) A STUDY OF THE STRUCTURE OF PLASMOIDS GENERATED BY AN ELECTRODELESS PLASMA GUN. Daniel R. Wells (Princeton Univ., N. J. Plasma Physics Lab.). May 12, 1963. Contract AT(30-1)-1238. 135p.

The gun consists of a cone-shaped single-turn coil energized by a low-inductance capacitor bank. A small quantity of cold gas is injected into the coil, is preionized by a separate single turn strap ringing at 400 kc, and then accelerated by the conical coil. A drift tube, which is centered in a long solenoid, acts as a guide field for the plasma. The plasmoids produced by the accelerator are then examined by employing various diagnostic devices at appropriate openings in the field windings of the solenoid. Observations of the plasma were made for two principal modes of operation of the conical coil. In one mode the coil is crowbarred so that the current is not allowed to reverse. The plasma then leaves the accelerator as a homogeneous stream that does not appear to rotate and, after entry into the collimating field region of the drift tube, forms a spheroidal structure with a long luminous tail. This structure does not appear to rotate and does not show evidence of any violent instabilities. In the second mode of operation, the coil is allowed to ring, and the current reverses many times as the capacitor bank discharges. The plasma now leaves the coil as a series of plasma vortex rings that move down the drift tube in a surrounding plasma mist, which moves with double the velocity of the rings. The rings are followed by rotating filamentary structures that are believed to be the residue of a second internal plasma ring formed during the compression. All of these structures merge when they enter the collimating field and form a single long rapidly rotating plasmoid. A simple model of plasmoid formation is developed by analyzing the current flow in the plasma. It is shown that Hall currents play a major role in the process. The equilibrium plasmoid structures are related to the corresponding velocity, vorticity, current and magnetic fields in the plasma. The field structures predicted by the model are compared with experimental measurements of trapped fields in the ring plasmoids. (auth)

4636 (NP-13296) ON THE RELATION BETWEEN LOUGHEAD'S PAPER ON ONE-DIMENSIONAL STEADY MHD-FLOW AND THE CAP THEORY. Technical Note No. 5. G. Kerer (Innsbruck. Universität. Institut für Theoretische Physik). [1961]. Contract AF61(052)-675. 8p.

Starting from the magnetogasdynamic equations for one-dimensional unsteady processes, under the assumptions of infinite electric conductivity and adiabatic behavior, it is shown that the characteristics thus found are reducible to those of a one-dimensional unsteady potential flow. (T.F.H.)

4637 (NP-13297) THE PRESSURE HILL AND THE ADIABATIC ELLIPSE IN MAGNETOGASDYNAMICS. Tech-

nical Note No. 3. Ferdinand Cap and R. Skarics (Innsbruck. Universität. Institut für Theoretische Physik). July 25, 1963. Contract 61(052)-675. 13p.

On the basis of Bernoulli's equations for a potential flow in magneto-gasdynamics, a formula of efflux is derived. Pressure as a function of the velocity of efflux is calculated for magnetic field strengths of 0, 5000, and 10,000 gauss. The equation of a modified adiabatic ellipse is deduced with the aid of an auxiliary quantity for calculation, closely based on gas dynamics. Furthermore, expressions interrelating the flow velocity, the modified Mach number, and the modified critical Mach number are studied. (auth)

4638 (NP-13298) APPROXIMATIVE SOLUTION OF THE MAGNETOHYDRODYNAMIC EQUATIONS FOR FINITE CONDUCTIVITY. Technical Note No. 4. F. Cap and G. Kerer (Innsbruck. Universität. Institut für Theoretische Physik). July 25, 1963. Contract AF61(052)-675. 3p.

Starting from the basic equations for steady two-dimensional potential flow, the basic magnetogasdynamic equations are linearized by means of perturbation calculations, assuming finite electric conductivity. Necessary and sufficient conditions for the existence of potential flow are discussed. (T.F.H.)

4639 (NP-13365) DIFFUSION IN A HIGHLY IONIZED PLASMA. Rijnhuizen Report 63-10. J. C. Terlouw and L. H. Th. Rietjens (Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Fysica, Jutphaas, Netherlands). July 1963. 10p.

Diffusion in the afterglow of a highly ionized plasma in cesium vapor was measured using Langmuir probes and microwaves. The results are compared with calculations in which the diffusion coefficient is assumed to be inversely proportional to the ion density, N. A more rapid decay of the electron temperature than can be expected on the basis of elastic collision losses was observed. The diffusion rate is influenced by this effect. When the density is decreased to an extent where collisions of ions with atoms become predominant, the diffusion coefficient becomes independent of N. For this case, the decay time was measured as a function of an axial magnetic field. The results can be interpreted with a collisional theory, taking axial diffusion into account. (auth)

4640 (TID-19722) QUARTERLY PROGRESS REPORT [ON PLASMA PHYSICS], AUGUST 1, 1963–OCTOBER 31, 1963. (New York Univ., New York). Nov. 4, 1963. Contract AT(30-1)-2397. 7p.

Research on production of Cs-seeded plasma and the emission of fast neutral atoms from plasma is outlined. (T.F.H.)

4641 (TID-19726) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 3. (Wisconsin. Univ., Madison). Oct. 15, 1963. Contract AT(11-1)-1233. 13p.

The construction of a toroidal octupole plasma device is outlined. A computer program for analyzing the magnetohydrodynamic stability of a plasma is discussed. (T.F.H.)

4642 (TID-19771) ENHANCED DIFFUSION IN AN R-F DISCHARGE IN THE PRESENCE OF A MAGNETIC FIELD. Technical Report No. 253-1. Richard Geller (Stanford Univ., Calif. Electron Devices Lab.). Aug. 1962. Contract AT(04-3)-326. (SEL-62-103)

It is shown that anomalous diffusion, which is present in arcs, positive columns, and PIG discharges where a static longitudinal electric field and a directed current are assumed, both parallel to a static magnetic field, also occurs in r-f discharges where there is no directed current. The applied r-f voltage is 200 volts peak to peak and is maintained constant. The electrodes were placed at either end of a glass tube enclosed in a solenoid. (R.E.U.)

4643 (AEC-tr-6131) INJECTION AND ACCUMULATION OF HIGH-ENERGY PARTICLES IN A MAGNETIC MIRROR SYSTEM. Cheng-wu Li. Translated from Sheng Li Hsueh Pao, 18: 586-93(1962). 14p.

A method of injecting beams of H_2^+ and H^0 into a magnetic mirror system is proposed. From an analysis of the flow of neutral gas in the system, a general equation for the rate of accumulation of protons and conditions for an exponential build-up of proton concentration is obtained. A parametric analysis shows that when the energy is within 10 to 100 kev, a strong magnetic field is helpful in the study of accumulation of particles. But choice of an optimum energy is far more complicated than the low-energy theory suggests. Under several conditions, and depending upon the purposes of the experiments, high energy is preferred. (auth)

4644 PLASMA HEATING BY ANOMALOUS DISSIPATION OF ALFVÉN WAVES PROPAGATING IN INHOMOGENEOUS MAGNETIC FIELDS. F. Winterberg (Case Inst. of Tech., Cleveland). Ann. Phys. (N. Y.), 25: 174-95(Nov. 1963).

Plasma Alfvén waves propagating in certain inhomogeneous magnetic fields suffer a strong anomalous viscous and ohmic dissipation. The dissipation is caused by transversal velocity differences of the wave resulting from the different propagation velocities along the lines of force. The effect may be useful for heating a plasma to high temperatures and may become competitive with the gyrorelaxation effect. The predicted rapid dissipation may also be of significance in astrophysical questions. The dissipation is studied for a simple inhomogeneous magnetic field. The results, however, can be semiquantitatively extended to less simple inhomogeneous fields. It is shown that the homogeneous magnetic field belongs to a wider class of magnetic fields that do not lead to anomalous dissipation of Alfvén waves. It is also shown that magnetic fields possessing this property have to satisfy a certain nonlinear partial differential equation. The anomalous dissipation is studied for a special model in further detail. There it is shown that the predicted anomalous dissipation is connected with the existence of a peculiar transversal wave that is strongly damped and that is propagating in a direction perpendicular to the lines of force. (auth)

4645 USE OF HIGH-FREQUENCY ELECTROMAGNETIC FIELDS FOR THE CONFINEMENT AND STABILIZATION OF PLASMA. S. M. Osovets. At. Energy. (USSR), 15: 283-92(Oct. 1963). (In Russian)

Study of confinement problems of hot plasma for accomplishing thermonuclear reactions involves primarily the determination of the time dependence of the magnetic field acting on the plasma. Among the methods used for this purpose are those making use of high-frequency magnetic and electric fields. High-frequency electromagnetic fields were proposed in 1957 in the Soviet Union for the stabilization of the various types of instabilities, as a basis for the construction of magnetic traps. Papers published in this field are reviewed, considering the interaction of the high-frequency field with the plasma. The action of the high-frequency field on the plasma may be examined by two methods: by using a relatively low-frequency field, letting only the magnetic field act, as the electric field E_ω is much weaker than the magnetic field H_ω, or by exposing the plasma to an electromagnetic field, in which

$E_{\sim} = H_{\sim}$. The dynamic stabilization methods are aimed at overcoming the magnetohydrodynamic instabilities of a quasi-stationary plasma coil and the convective instabilities in adiabatic traps. The complex engineering problems that must be solved include the construction of more powerful generators, able to deliver up to 1000 Mw in a 1-msec pulse; design of condensers with 50 to 100 times higher capacity than available at present, and the construction of high-vacuum ceramic containers. The losses due to skin must be considerably reduced, probably by using superconductors. (TTT)

4646 STUDY OF THE MOTION OF SINGLE CHARGED PARTICLES IN CORRUGATED MAGNETIC FIELDS. V. M. Balebanov, V. B. Glasko, A. L. Groshev, V. V. Kuznetsov, A. G. Sveshnikov, and N. N. Semashko. At. Energ. (USSR), 15: 318-19(Oct. 1963). (In Russian)

The channel instability in traps with magnetic plugs may be avoided if particles are able to drift azimuthally in an opposite direction to the Larmor circle rotation and if the drift rate is sufficient to compensate for the electric forces generated in the plasma. Solution of the problem of the motion of charged particles in a corrugated magnetic field showed that there is an angular region for the injection for which the drift is larger than zero. An increase of the modulation of the field results in an increase of the azimuthal drift. The calculations also indicated that changes of the magnetic momentum of a particle depend on the location of the point of injection with respect to the field minimum. The problem of the motion of single charged particles in a periodic magnetic field was studied experimentally in the EMO-1 and EMO-2 machines, representing 1:8 scale electronic models of "Ogra." The studies with EMO-1 showed that the nature of the drift velocity depends greatly on the point of injection and the reflection of the particles with respect to the field minimum. On the EMO-2 machine, the drift was determined on the basis of the lifetime of the particles after injection of the beam; it was found that the drift velocity increases with increasing modulation of the field. (TTT)

4647 MEASUREMENT OF PLASMA TEMPERATURE AND ELECTRON DENSITY. Kiyoshi Murakawa and Shizuyo Hashimoto (Tokyo Univ.). Bull. Aeronaut. Res. Inst., Univ. Tokyo, 3: 319-32(June 1963). (In Japanese)

Plasma was produced by passing a discharge through a quartz capillary tube containing neon at about 1-mm Hg pressure. The profiles of the lines Ne III λ2590, Ne II λ3713, and Ne I λ6096 were examined. These three lines show quadratic Stark effect. The profiles of λ2590 and λ3713 lines were found to be nearly symmetrical, so the effect of the ionic and electron fields was assumed to be negligible, namely the broadening was assumed to be due solely to Doppler effect. The line λ6096 was found to be unsymmetrically broadened, being degraded more strongly to the longer wave-length side. This was interpreted to be due to the ionic field effect (Holtsmark type), as well as the electron effect, (Lorentz type), and the Doppler effect. The profiles studied were time-integrated. From the profiles of the lines the mean plasma temperatures of 1.0×10^5, 9.3×10^4, and 3.6×10^4 °K were deduced. At the same time the time-resolved output of the photomultiplier was studied, and the plasma temperature as a function of time was qualitatively derived. From Ne I λ6096 the mean electron density $7.7 \times 10^{15}/cm^3$ was obtained. (auth)

4648 PLASMA ACCELERATION BY STATIC MAGNETIC AND ELECTROMAGNETIC FIELD GRADIENTS. Térenzio Consoli and Richard Hall. Compt. Rend., 257: 2440-3(Oct. 21, 1963). (In French)

The principles of a device capable of accelerating a plasma jet are given. Some results of the theoretical study of this principle are reported. (tr-auth)

4649 EXPERIMENTAL STUDY OF THE CUTOFF IN THE PROPAGATION OF A RIGHT POLARIZED WAVE IN AN IONIZED MEDIUM ALONG A MAGNETIC FIELD. Térenzio Consoli, Georges Ichtchenko, François Parlange, and Micheline Weill. Compt. Rend., 257: 2620-3(Oct. 28, 1963). (In French)

An experiment in which the cutoff of a right circular wave can be observed is described. The experimental results are compared to a theoretical result assuming an increased frequency of collisions. (tr-auth)

4650 FIRST EXPERIMENTAL VERIFICATION OF THE ACCELERATION OF A PLASMA BY STATIC MAGNETIC AND HF FIELD GRADIENTS. Térenzio Consoli and Richard Hall. Compt. Rend., 257: 2804-7(Nov. 4, 1963). (In French)

The experimental apparatus used to verify the principle of the acceleration of plasma jets by static magnetic and HF field gradients is described. (tr-auth)

4651 PLASMA CONTAINMENT IN A UNIT WITH A HIGH-FREQUENCY, TRAVELLING MAGNETIC FIELD. N. A. Borzunov, N. Ya. Kuz'mina, I. Kh. Nevyazhskii, S. M. Osovets, Yu. F. Petrov, B. I. Polyakov, I. A. Popov, K. V. Khodataev, and V. P. Shimchuk (Inst. of Physics of High Pressures, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 581-4(Sept. 21, 1963). (In Russian)

The unit consists of inductive elements surrounding a toroidal discharge chamber of quartz with an outer torus diameter of 70 cm and an inner diameter of 8 cm. A total of 12 high-frequency traveling waves at 2.5×10^6 cycles/sec with a phase velocity of 5×10^7 cm/sec are superimposed on each other. The peak power is 60 Mw for a period of 300 to 600 μsec. The direction of propagation of the traveling wave is fixed by the design of the generator. The gas is ionized by the electric field of the traveling wave. The amplitude of the magnetic wave H_z increases from the axis to the periphery of the torus so that magnetohydrodynamic stability is assured. The effective conductivity of the plasma was found to be $\sigma_{eff} = 2.5 \times 10^{13}$ CGSE units. This value is an order of magnitude less than the value of 4×10^{14} CGSE units, which should be the conductivity for an electron temperature of 10 ev and an electron concentration of 1.7×10^{14} cm^{-3}, as determined experimentally. The anomalously high absorption of the energy of the traveling electromagnetic wave, and the low effective conductivity of the plasma open up the possibility of heating a plasma to high temperatures by this method. The low value of the effective conductivity can be explained by magnitization of the plasma due to the observed directional drift of electrons. Further studies are being conducted on the effects due to break-away of the plasma from the walls of the chamber, where the strength of the magnetic field is high. These effects tend to occur at low initial hydrogen pressures (2×10^{-3} mm), and are especially prominent during discharge in air at a pressure of 5×10^{-4} mm. (TTT)

4652 THE THEORY OF A SLIGHTLY TURBULENT PLASMA. V. I. Karpman. Dokl. Akad. Nauk SSSR, 152: 587-90(Sept. 21, 1963). (In Russian)

The interactions between harmonics in relaxation processes were investigated for a plasma without a magnetic field, when the wave decrement is rather small ($\gamma \ll \omega$). An expression was written for the electric field of the plasma oscillations. The amplitude of the electric field $E_p(t)$ was determined by a slowly-varying, average distribution func-

tion, and by the non-linear interaction between harmonics. The characteristic time of change $N_p(t) = |E_p(t)|^2$ was calculated by averaging all the phase values of E_p at a given moment. On considering the relaxation of electron oscillations in a dilute plasma, the energy of the wave was large compared to the average kinetic energy of the particles. Two stages in the relaxation of the oscillations can be distinguished. First, a "plateau" is formed in the resonance region of velocities $v \sim \omega/k \gg v_T$ (v_T is the thermal velocity of the electrons). This stage is described by ordinary, quasilinear theory. As a result of non-linear interaction, particular plasma oscillations produce forced oscillations with frequencies $\omega_{k'} \pm \omega_{k''}$, and with wave vectors $k' \pm k''$, which effectively interact with particles having a velocity $v = (\omega_{k'} \pm \omega_{k''})/(|k'| \pm |k''|)$. This interaction leads to additional absorption. (TTT)

4653 GRAVITATIONAL INSTABILITY IN A PLASMA IN A MAGNETIC FIELD. III. PARTICLE ASPECT. Ichiro Kawakami and Masatomo Sato (Nihon Univ., Japan). Kakuyugo Kenkyu, 10: 463-91(June 1963). (In Japanese)

The instability of a plane boundary of plasma supported under gravity by a magnetic field was investigated in the first order orbit theory taking into account the collisions between particles, where the collision frequency is assumed small as compared with the Larmor frequency. It is demonstrated that the instability growth rate may be suppressed by collisions of ions with neutral particles (for a weakly ionized plasma) or among themselves (for a fully ionized plasma). The physical mechanism of the stabilization is the discharge of surface charges as a result of the collisional drift motion of ions, which takes place across the magnetic field in the direction of the produced electric field. A nonlinear effect is also discussed within the validity of the surface charge. (auth)

4654 MOTION OF CHARGED PARTICLES IN CUSPED GEOMETRY. Hiroshi Ito, and Kazutomo Matsuyama (Osaka Univ.). Kakuyugo Kenkyu, 10: 492-513(June 1963). (In Japanese)

Behaviors of charged particles injected from the entrance cusp were studied using Norton's field. Regions in which the orbits of particles exist are easily determined using various initial conditions at the cusp throat. Detailed loci of particles were obtained using an electronic computer. Orbits near point and line cusps were worked out approximately and agree closely with the calculated ones. (auth)

4655 ANALYSIS OF PULSE PROBE. Takashige Tsukijima (Nagoya Univ., Japan). Kakuyugo Kenkyu, 10: 514-26(June 1963). (In Japanese)

It is shown that, for an electron plasma, the current flowing into a pulse probe is given approximately by $\delta j(0,t) = \delta j_0 \cdot e^{-\nu t} \sin\omega_p t$, where δj_0 is a constant proportional to $\delta V_0/L$ and the electron density, ν and ω_p are the collision frequency and plasma frequency, respectively. A discussion is given on the current response for an electron-ion plasma. (auth)

4656 CRITICAL ELECTRIC FIELD OF THE ANOMALOUS DIFFUSION IN THE POSITIVE COLUMN. DIFFUSION PHENOMENA OF THE POSITIVE COLUMN IN A MAGNETIC FIELD. PART II. M. Sato and Y. Hatta (Tohoku Univ., Japan). Kakuyugo Kenkyu, 11: 1-10(July 1963). (In Japanese)

Critical electric field at which the anomalous diffusion phenomena occur in a positive column in a longitudinal magnetic field is numerically calculated. The critical field value was theoretically calculated from the critical electric field measured by a probe. Numerical calculations for He gas agree with experimental results. (auth)

4657 ON THE MECHANISM OF THE DYNAMIC BEHAVIOR OF A PLASMA IN A FAST THETA PINCH. Masuo Shindo, Nagayasu Ikeda, et al. (Tokyo Inst. of Tech.). Kakuyugo Kenkyu, 11: 21-35(July 1963). (In Japanese)

The effect of a rapid change of the reverse magnetic field on a fast theta pinch and the dynamic behavior attendant were clarified. The rapid change of the field from the surface and near the center of the plasma, after the time at which the shock front collides at the center axis, was explained. In addition, the mechanisms of accompanying behaviors such as the rotating motion and the unexpectedly great temperature rise were explained. (auth)

4658 MICROWAVE REFLECTION COEFFICIENT OF PLASMA AS A FUNCTION OF ELECTRON DENSITY, COLLISION FREQUENCY, AND CYCLOTRON FREQUENCY. AUTOMATIC MEASURING APPARATUS OF MICROWAVE REFLECTION COEFFICIENT FOR SHOCK WAVE STUDY. Sadao Nakai and Chiyoe Yamanaka (Osaka Univ.). Kakuyugo Kenkyu, 11: 36-57(July 1963). (In Japanese)

The characteristics of the microwave reflection coefficient were calculated by an electronic digital computer as a function of electron density, collision frequency, and cyclotron frequency. An automatic apparatus was constructed to measure the microwave reflection coefficient. Applying the experimental results to calculated charts of reflection coefficients, the final data on electron density and collision frequency under various magnetic fields are easily found. Charts of the reflection coefficients and descriptions of the measuring apparatus are presented. (auth)

4659 EXPERIMENTS ON MAGNETIC COMPRESSION OF TOROIDAL PLASMA. Tadashi Kawai, Hiromichi Kondo, et al. (Mitsubishi Electric Co., Japan). Mitsubishi Denki Giho, 36: 826-32(June 1963). (In Japanese)

Experiments were conducted to study the compression of self-pinched air plasma produced by Joule heating in a glass torus. In the experiments it was made clear that the plasma is rapidly compressed toward the axis of the torus and continues in a state of stable confinement for a few tens of μs. Observations and measurements of current and voltage made it possible to deduce a number of conclusions and conjectures about the effect of various experimental parameters not only on the plasma after compression but also behavior of self-pinched plasma. (auth)

4660 EXPERIMENTAL RESULTS OF RESONANCE OBSERVATIONS IN DIFFERENT CYLINDRICAL PLASMAS. A. M. Messiaen (Ecole Royale Militaire, Brussels). Physica, 29: 1117-18(Oct. 1963). (In French)

The origin of secondary resonances in a cylindrical plasma column excited by a dipolar electric field is investigated. Values were obtained for the ratio of the resonance currents and amplitudes as a function of pressure, the electron temperature, the electron mean-free-path, and the frequency of collision of the electrons with molecules and the wall. Plasmas investigated were Hg, Cs, Ar, Ne, He, N_2, and H_2. (C.E.S.)

4661 PLASMA PHENOMENA AND SUPERNOVA OUTBURSTS. D. A. Frank-Kamenetskii. Soviet Astron.-AJ (English Transl.), 7: 349-56(Nov.-Dec. 1963).

The physical processes occurring in the contraction stage, prior to the supernova event, of a star containing no sources of energy are considered. The neutronization

process in the central zone of the star produces a solution of the plasma in the neutron fluid (a neutroplasma). In α-neutroplasma, the electron charge is compensated by helium nuclei, and in β-neutroplasma by the positrons arising in equilibrium lepton-pair formation. The electric conductivity of neutroplasma is very high. In the α-neutroplasma region, the electron-pressure gradient induces electrical polarization. In the transition layer between the core and envelope of the star, convective motion in the electric field transforms the energy of contraction into magnetic energy. The resulting magnetic pressure sets off the explosion of a type I supernova. For type II supernovae, the gravitational radius is approached before nuclear density is reached. Epigravitational phenomena occur in which gravitation and strong interactions function simultaneously. The most important such phenomenon is the formation of epiplasma, a mixture of nucleons and antinucleons, stabilized by high temperature and the gravitational field. A mass of epiplasma is unstable with respect to local asymmetric rarefactions, and so is annihilated. This epigravitational instability sets off the explosion of a type II supernova. The annihilation of epiplasma in the remnants of the supernova may serve as a source of energy for various nonthermal-radiation processes. (auth)

4662 THE NONLINEAR COUPLING OF PLANE PLASMA OSCILLATIONS AND PARAMETRIC AMPLIFICATION. Fritz Paschke (Siemens and Halske AG, Munich). Z. Angew. Phys., 16: 162-7(Sept. 1963). (In German)

The rigid solution of the differential equation that describes the nonlinear coupling of symmetric and asymmetric plasma oscillations is adequate for the one-dimensional plasma model. The symmetric oscillation with the Langmuir-Tonks frequency ω_p can serve as a pump in a parametric plasma diode amplifier. The theory predicts amplification in the region $0 < \omega < 2\ \omega_p$. In opposition to conventional parametric amplifiers, amplification at frequencies over the pump frequency is possible. (tr-auth)

4663 TWO NEW TYPES OF PHOTOELECTRON MULTIPLIERS FOR INVESTIGATIONS OF SHORT-LIVED PLASMAS. German Pfund (Technische Hochschule, Stuttgart). Z. Angew. Phys., 16: 187-9(Sept. 1963). (In German)

Two new types of photomultipliers, one battery-powered and the other powered by a low-current, high-voltage cascade, are described. The resolution was improved with respect to other photomultipliers, and the susceptibility to noise considerably reduced. Since photomultiplier, high-voltage source, and tuning stage are well shielded in a relatively small housing, these devices are distinguished by simple and inexpensive construction, great stability, high sensitivity, and improved manageability. The low-current, high-voltage device is suitable for use in long measurement series in research installations with weak perturbance fields and for triggering. The battery-powered device can be used for accurate measurements in strong interfering fields. (tr-auth)

4664 PLASMA ACCELERATION BY TRAVELING MAGNETIC FIELD. R. M. Head, R. H. Huddlestone, E. B. Mayfield, and R. X. Meyer (Aerospace Corp., El Segundo, Calif.). p.137-150 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

Experiments are described, which were conducted to study the feasibility of using the interaction of a moving magnetic field with highly ionized plasma in a plasma propulsion system. A 10-kv helical transmission line was used in the first experiments. It could increase the velocity of the initial ionizing shock from 2 to 6 cm/μsec, but it could not maintain the shock at the phase velocity of the line over the entire length of the accelerator. The design and construction of a 25-kev accelerator using 2 helices are described. An essentially constant shock velocity equal to the transmission-line velocity was obtained with the accelerator in operation, and a pronounced velocity decay was observed without it. (M.P.G.)

4665 MOMENTUM TRANSFER THROUGH MAGNETIC FIELDS. G. S. Janes, J. Dotson, and T. Wilson (Avco-Everett Research Lab., Everett, Mass.). p.153-76 of "Advanced Propulsion Concepts. Vol. I." New York. Gordon and Breach Science Publishers, 1963.

Electric-magnetic-region d-c plasma accelerators have a number of significant potential engineering advantages. These include: freedom from the space charge limitations of conventional ion rockets; magnetic containment possibilities; high acceleration voltages, which depend only upon the specific impulse rather than upon the instantaneous power level, thereby minimizing arc-voltage-drop problems; a readily variable specific impulse and power level; extreme simplicity in the associated electrical circuitry; and convenient physical size together with moderate power levels, electrostatic voltage gradients, magnetic field strengths, and heat transfer rates. Experiments are described, which establish the basic soundness of the E.-M.-region mechanism for the electrostatic acceleration of low density plasma by momentum transfer through magnetic fields. The experiments further indicate that electron leakage currents, which are of sufficient magnitude to account for the necessary ionization mechanism, definitely do not obey the classical diffusion formula and show fairly good agreement with the anomalous diffusion formula proposed by Bohm. This may be a serious limitation on the overall performance of this type of device. The necessity for the production of ionization by means of electron leakage currents probably precludes the possibility of searching for a domain of operation in which the electron currents are diminished. By establishing a physical separation between the ionization and the acceleration phases of this device, it should be possible to search for a more quiescent domain of operation, in which the anomalous electron diffusion associated with density fluctuations may be significantly reduced. An annular E.-M.-region d-c accelerator, which eliminates the necessity for electron leakage currents as a source of ionization, is being investigated. Sufficient data are not yet available to draw any conclusions on the basis of experiments performed with this device. (auth)

4666 CONTROLLED FUSION PROPULSION. John S. Luce (Aerojet-General Nucleonics, San Ramon, Calif.). p.343-80 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

Research in controlled fusion propulsion is discussed. A space fusion research program independent of the terrestrial fusion program is necessary because of the basic difference in motivation. The $He^3 + D \rightarrow He^4 + H$ reaction, which may be feasible since modern superconductors can maintain the required high magnetic fields, is the best reaction for space applications, since no neutrons are produced. Research on the problems of plasma confinement, injection, trapping, and ignition is discussed, and the application of current fusion research to space propulsion is briefly mentioned. (M.P.G.)

4667 FUSION PLASMA PROPULSION SYSTEM. William I. Linlor and Milton U. Clauser (Hughes Research Labs., Malibu, Calif.). p.381-407 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The development of high magnetic field superconductivity, lasers coupled with intense photon sources, and cryogenic pumping techniques has increased the feasibility of using fusion power in a space propulsion system. The present status of fusion research is evaluated. One of the most difficult problems to be solved is plasma instability. Two methods of fusion plasma production, electric field dissociation and photodissociation, are described in detail. The conceptual design of a space propulsion system employing fusion power is outlined. Many problems must be solved before the system can be considered feasible, but the advantages of the system make it worth the effort. (M.P.G.)

4668 VOPROSY TEORII PLAZMY. VYPUSK I. (Problems in the Plasma Theory. Number I). M. A. Leontovich, ed. Moscow, Gosatomizdat, 1963. 288p.

Four articles are included on problems in plasma theory. Plasma behavior in magnetic field, plasma transport, and particle capture by external fields are analyzed. Separate abstracts have been prepared for each article. (R.V.J.)

For abstracts of individual papers see: 4669, 4670, 4671, and 4672.

4669 DRIFT THEORY OF CHARGED PARTICLE MOTION IN ELECTROMAGNETIC FIELDS. D. V. Sevukhin. p.7-97 of "Voprosy Teorii Plazmy. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

The theory of charged particle motion in a constant magnetic field was analyzed. Guiding center drift and the origin of drifts are discussed, and a complete system of equations of motion for drift approximation is presented. Various problems on plasma drift in electric and magnetic fields are resolved. (R.V.J.)

4670 COLLISION OF PARTICLES IN COMPLETELY IONIZED PLASMA. B. A. Trubnikov. p.98-182 of "Voprosy Teorii Plazmy. Vypusk I." Moscow, Gosatomizdat, 1963.

An analysis was made of simple kinetic effects resulting from particle collisions in a completely ionized uniform gas. An attempt was made at simple graphical presentation. Special potential functions and electrostatic analogues were used for formula simplification. Collisions in a completely ionized plasma, test particle mobility, kinetic equations for Coulomb interactions, and simple plasma kinetics are discussed. (R.V.J.)

4671 PLASMA TRANSPORT PHENOMENA. S. I. Braginskii. p.183-272 of "Voprosy Teorii Plazmy. Vypusk I." Moscow, Gosatomizdat, 1963.

Transport and kinetic equations in a simple plasma were analyzed, and certain paradoxes were evaluated. Descriptions are given of hydrodynamic and multicomponent plasma. (R.V.J.)

4672 PLASMA THERMODYNAMICS. A. A. Vedenov. p.273-85 of "Voprosy Teorii Plazmy. Vypusk I." Moscow, Gosatomizdat, 1963.

Problems in statistical thermodynamics and particle Coulomb interactions were studied. Calculations were made of thermodynamic functions for particle interactions at thermal equilibrium. Only weak nonideal gas systems with Coulomb forces were studied. One parameter in such a case is the ratio f/r for the mean Coulomb scattering amplitude, where $f \sim e^2/E$ and $r \sim n^{-\frac{1}{3}}$. Thermodynamic plasma potential was expanded along this parameter, and an analysis was made of the primary terms in the expansion. (R.V.J.)

4673 DIFFUSED PLASMA BOUNDARIES AND SOME ASPECTS OF ELECTROMAGNETIC WAVE SYNTHESIS. Nabil Hasan Farhat. Thesis, Philadelphia, Univ. of Pennsylvania, 1963. 99p.

The phenomenon of interaction of electromagnetic (EM) waves and plasma was used as a basis for a study of the logical conjugate to the plasma diagnostic problem. That is, information about some of the properties of the interacting wave was obtained through measurement of the plasma parameters affected most by the wave. The electron distribution is considered in a special class of plasma boundaries (space charge sheath) that may form in dilute plasmas where free electron diffusion occurs. The electron concentration is shown to increase from a uniform value in the bulk plasma to approximately twice this value at the wall. It is further shown that the presence of such a boundary (sheath) does not cause any appreciable reflection in an incident EM wave. The effect of the EM wave on the plasma parameters is shown to be conveyed primarily through the action of the field on the electrons in the plasma. This action is manifested by an increase in the electron temperature, which is derived from an electron energy balance equation. This is shown to be dependent on the electric field component of the interacting microwave, its frequency, the nature of the gas, and its pressure. The theory of operation of a glow discharge microwave energy detector is also presented. It is shown that the functioning of the detector is closely determined by the dependence of the diffusion coefficient in the Faraday region of the discharge on electron temperature. Experimental verifications show close agreement between theory and practice, also demonstrate the excellent potentialities of the device in practical applications, particularly in microwave power density measurement. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4674 INTERACTION OF MICROWAVES IN GASEOUS PLASMAS IMMERSED IN MAGNETIC FIELDS. Kotcherlakota Venkata Narasinga Rao. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 175p.

The phenomenon of radio frequency electromagnetic wave interaction in gaseous plasmas is discussed. The technique of microwave interaction with a plasma and the simultaneous observation of the afterglow light intensity were employed to investigate gaseous plasmas immersed in external magnetic fields. Attention was focused especially on the effects produced in such plasmas when one of the simultaneously propagating microwaves is in electron-cyclotron resonance. It is demonstrated that for relatively modest amplitudes of the resonating wave the kinetic energy of the electrons increases considerably, which in turn effects the electron collision frequency and the magnetic field control of the plasma confinement. The enhancement of the electronic energy caused by the cyclotron resonance absorption of microwave energy is evidenced in the propagation characteristics of resonant and non-resonant electromagnetic waves, the visible excitation light intensity of the plasma, and the emission of microwave noise power from the plasma. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4675 MAGNETIC INDUCTION DISCHARGES. Roger Clyde Jones. Thesis, College Park, Md., Univ. of Maryland, 1963. 293p.

A theoretical and experimental investigation was made of magnetic induction discharges, which are defined as

discharges in which the exciting electric field is due solely to the time derivative of a vector potential. Both cylindrical and spherical discharges were investigated, using hydrogen, deuterium, and helium gases. The cylindrical magnetostatic magnetic induction discharge uses helium and neon gases, with an applied d-c magnetic induction of up to 4000 gauss directed along the axis of the cylinder. The cylindrical magnetic induction discharge, which has been called a ring, "H," or curl E discharge, received most of the attention, although an extensive theoretical and experimental investigation of the spherical magnetic induction discharge was also conducted. It is shown that all previous breakdown data on magnetic induction discharges are invalid, as fields due to the gradient of scalar potentials have been present. Both theoretically and experimentally, it is shown that the breakdown values for a pure magnetic induction discharge are substantially lower than for an E-type discharge (a discharge in which the exciting electric field is due to the gradient of a scalar potential). The spherical discharge exhibits higher breakdown field strengths for low pressures than does a cylindrical discharge; the converse is true at sufficiently high pressure. Both this phenomenon and the low breakdown field strengths of magnetic induction discharges in general are explained in terms of the different significance of inward and outward (in the radial direction) diffusion, together with the characteristic spatial distribution functions that appear. Least maintaining field strengths were also treated, together with a discussion of obtaining recombination coefficients from accurate data. Data are accumulated for every case in which breakdown data were obtained; as expected, the form of the resultant curves are very similar to the breakdown curves, and the magnitudes are significantly lower. A theoretical treatment of velocity and phase-space distribution functions is also given. A velocity distribution function was obtained and a true phase-space distribution function is obtained by using Fourier and Hankel transforms operating on the partial differential equation derived from the Boltzmann equation. Refined methods of including the effects of inelastic collisions, such as the calculation of a partial distribution function for the electrons reentering phase-space, are given. Both theoretical and experimental work was carried out with regard to the spatial distribution functions. A number of differential equations were programmed for the IBM 1620 computer, and several diffusion current density potential distribution functions were obtained. The data presented are extremely accurate, and dependable results for several characteristics of magnetic induction discharges are presented. (TCO)

4676 THE EFFECT OF BINARY PARTICLE CORRELATIONS ON PLASMA OSCILLATIONS. Darwin J. Harwood. Thesis, Lafayette, Ind., Purdue Univ., 1963. 76p.

By means of the kinetic theory description of a plasma, the classical theory of small amplitude oscillations of an unbounded electronic plasma was investigated. Starting with an integrated form of the Liouville equation and replacing the two-particle distribution function by a product of single-particle distribution functions and a correlation function, an equation describing the single-particle distribution function was derived. The interactions of the particles by means of their Coulomb repulsion forces were included but magnetic interactions between particles were neglected. A constant external magnetic field was assumed to be present but no external electric field. Only small disturbances of the plasma were considered so that the distribution function was assumed to depart from the equilibrium Maxwellian distribution by only a small but otherwise arbitrary function and nonlinear terms in the disturbance were neglected. The linearized equation was solved by means of Fourier transforms. A dispersion equation was derived for longitudinal waves and this was treated for various special cases. It is shown that in no case do solutions of increasing amplitude arise and in fact all waves except those propagating exactly perpendicular to the magnetic field are damped. It was found that the effect of the correlations is to decrease the frequency and increase the damping, especially for short wavelength waves. This is in accord with physical intuition. The region of temperature and density of the plasma for which correlation effects become important was seen to border on the region where a quantum mechanical theory is necessary to describe the plasma. It was concluded that correlation effects are rather unimportant for classical plasmas, at least for high frequency phenomena, and thus that the Vlasov-Boltzmann equation is sufficiently accurate to describe these phenomena. (TCO)

4677 PLASMA GENERATION AND CONTROL: THE MAGNETOPLASMADYNAMICS OF A ROTARY ARC PLASMA GENERATOR. Charles Henry Miller. Thesis, Toronto, Univ. of Toronto, 1962. 203p.

An examination and engineering correlation was made of the rapidly increasing available knowledge in plasma physics. Two paths, connecting the various analytical models of the electromagnetic and thermodynamic phenomena involved, were assembled and evaluated. The first is based on the rigorous approach of microscopic models, the second upon a heuristic, or macroscopic model, interpretation. The latter was found to be more consistent with the engineering philosophy and the more likely to be productive of effective plasma machinery. In order to contribute useful engineering design data, it was necessary to evolve a magnetoplasmadynamic test facility equipped for the performance evaluation of plasma generators. The macroscopic approach and the test facilities developed were exercised on the design, construction and test proving of a novel plasma generator based upon an open system, rotary arc configuration, and intended to be the first stage of a cascaded propulsion engine. The design concepts of the device were substantially confirmed by the immediate starting and stable running achieved, without the need for dimensional, power loading or thermal loading design changes. The results of the initial group of tests were analyzed and effectively correlated. Arc resistivity is shown to be variable over a wide range, within close control, by the manipulation of the strength of the external magnetic field. An arc resistivity, based on a current density incorporating a gas mass flow rate dependency (rather than the more usual unit area function), is shown to correlate well with the ideal particle velocity. Similar correlations were obtained for arc power absorbed, and for a Lorentz force parameter utilizing the same current density, but requiring as well a gas pressure term. It was concluded that these methods will permit the presentation of a complete set of performance parameters for this basic generator configuration. Certain polarity permutations were observed to affect the stability of the arc. This, together with the direct view available of the rotary arc, commends this form of apparatus for the study of retrograde arc motion. (TCO)

4678 THE HALL EFFECT AND ELECTRON DRIFT VELOCITIES IN THE PLASMA OF THE POSITIVE COL-

UMN. J. M. Anderson (General Electric Research Lab., Schenectady, N. Y.). 23p. (CONF-78-20).

From American Physical Society 1963 Summer Meeting, Buffalo, June 1963.

The Hall potential was observed for positive columns established at pressures near 1 torr in helium, neon, argon, and nitrogen. Simultaneous measurement of the density of electrons in the column by the microwave cavity technique gives an independent determination of the electron drift velocity. The proportionality factor, α, between the Hall field measured and the product of the drift velocity and applied magnetic field was determined. The factor α for the case of helium varied from $\cong 0.6$ at $E/p = 4$ to $\cong 0.85$ at $E/p = 20$; theoretically this factor should be 0.5. For neon and argon, $\alpha = 0.6 \pm 0.1$ experimentally. For nitrogen, α varied from nearly 0.5 at $E/p = 40$ to <0.3 at $E/p = 150$ ($p = 0.045$ torr), in general accord with theory. Electron collision frequency for momentum transfer was determined by microwave methods and also from the d-c mobility. (auth)

4679 PLASMA CONFINING DEVICE. Jean-Michel Dolique (to Compagnie Générale de Télégraphie sans Fil). Canadian Patent 657,281. Feb. 5, 1963. Priority date June 2, 1959, France.

An annular plasma-confining device with magnetic bottles is designed with means for increasing the tightness of the throats of the magnetic bottles. The means apply a high-frequency electromagnetic field between electrodes within each mirror so as to establish a pattern of standing transverse hydromagnetic (Alfven) waves, of which the antinodes are disposed at the levels in the mirrors. (D.L.C.)

4680 PROCESS AND APPARATUS FOR PRODUCING ENERGY BY NUCLEAR FUSION. Jiri G. Linhart. Canadian Patent 661,637. Apr. 23, 1963. Priority date Dec. 3, 1959, Belgium.

A reactor is designed for conducting efficient thermonuclear reactions. The reactor comprises a pair of circular electrodes and a cylindrical insulating wall between the electrodes having radial small orifices. A high vacuum ($\sim 10^{-6}$ mm Hg) is attained in the reactor, an electrical discharge is applied between the electrodes, and puffs of gas are introduced intermittently into the reactor through the orifices. (D.L.C.)

4681 HEAT GENERATION. Donald H. Imhoff and Wesley H. Harker (to U. S. Atomic Energy Commission). U. S. Patent 3,113,082. Dec. 3, 1963.

Heat is generated by the utilization of high energy neutrons produced as by nuclear reactions between hydrogen isotopes in a blanket zone containing lithium, a neutron moderator, and uranium and/or thorium effective to achieve multiplication of the high energy neutron. The multiplied and moderated neutrons produced react further with lithium-6 to produce tritium in the blanket. Thermal neutron fissionable materials are also produced and consumed in situ in the blanket zone. The heat produced by the aggregate of the various nuclear reactions is then withdrawn from the blanket zone to be used or otherwise disposed externally. (AEC)

4682 APPARATUS FOR THE GENERATION AND CONFINEMENT OF HIGH KINETIC ENERGY GASES. Vernal Josephson (to Space Tech. Labs.). U. S. Patent 3,113,088. Dec. 3, 1963. Filed July 27, 1959.

A system for combining crossed magnetic fields to establish a continuing pinch effect in a plasma is described. A klystron with a resonant re-entrant cavity concentrically encompasses a plasma-containing torus. A magnetic drive about the torus may be used to initiate a dense pinching current in the plasma. The drive is abruptly short-circuited at current maximum to cause a trapped current to flow in the plasma circularly about the torus. The pinch phenomenon results from an encompassing direct-current magnetic field about the current. The klystron is caused to oscillate during the flow of trapped pinch current in the plasma. The standing wave modes in the resonant cavity of the klystron produce the desired radiofrequency magnetic fields that extend through the torus around the plasma region. These radiofrequency magnetic fields are applied to the plasma in a direction that is preferably orthogonal with respect to the direct-current magnetic fields. The fields together insure stable containinment of the pinched plasma. (M.C.G.)

4683 METHOD FOR EXCHANGING ENERGY WITH A PLASMA BY MAGNETIC PUMPING. Laurence S. Hall (to U. S. Atomic Energy Commission). U. S. Patent 3,116,209. [Dec. 31, 1963].

A method of heating a plasma confined by a static magnetic field is presented. A time-varying magnetic field having a rise time to a predetermined value substantially less than its fall time is applied to a portion of the plasma. Because of the much shorter rise time, the plasma is reversibly heated. This cycle is repeated until the desired plasma temperature is reached. (AEC)

Shielding

4684 (NRL-5981) STOCHASTIC ESTIMATES OF THE PENETRATION OF GAMMA RAYS THROUGH SLAB SHIELDS. A. G. Pieper and L. A. Beach (Naval Research Lab., Washington, D. C.). Sept. 26, 1963. 32p. (AD-422646)

The energy penetration and dose-rate buildup factors are calculated by Monte Carlo techniques on a digital computer for a plane, monodirectional source of gamma rays of 1.0, 2.5, and 6.0 Mev, incident at various angles upon finite slab shields of lead, iron, ordinary concrete, and water. The exponential transformation and equivalent integration over the spatial variable are utilized to obtain results for slabs up to 18 mean-free-pathlengths in thickness. A simple expression is derived, which relates a given buildup factor at any incident angle to the corresponding buildup factor at normal incidence. (auth)

4685 CALCULATION OF THE PASSAGE OF NEUTRONS THROUGH A FLAT POLYETHYLENE LAYER. S. M. Ermakov, V. G. Zolotukhin, and E. E. Petrov. At. Energy. (USSR), 15: 253-5(Sept. 1963). (In Russian)

Knowledge of the factors involved in the passage of neutrons through polyethylene is of considerable importance for the design of nuclear power station shields. Monte Carlo calculations were made for a beam of monoenergetic neutrons with initial energies of E_0 of 0.3, 1, and 2 Mev passing through 5, 10, and 15-cm thick polyethylene layers at incident angles of 0, 15, 30, 45, and 75°; the density of the material was taken as 0.92 g/cm^3. The number of neutrons emerging from the polyethylene layer within the given energy and angular range, the total number of reflected neutrons and the distribution of thermal neutron sources in the layer were computed from these data. In order to obtain the neutron spectrum, the energy range, from the initial value E_0 to the thermal range, was divided into 7 intervals according to the lethargy; for the determination of the angular distribution, the half space was divided into body angle elements on the basis of the cosines of the polar and azimuthal angles; the albedo was used for

calculating the reflected neutrons. The results, computed with an error of about 5%, are presented graphically. (TTT)

4686 ATTENUATION OF A HIGH-ENERGY NEUTRON FLUX IN THE SHIELD. M. M. Komochkov and B. S. Sychev. At. Energ. (USSR), 15: 325-7(Oct. 1963). (In Russian)

The attenuation of a neutron flux in Fe was examined by using an approximation theory which satisfies the experimental data. The flux density and the neutron energy spectrum were determined by solving the kinetic equation for a monodirectional neutron flux which is perpendicularly incident on a semi-infinite absorber with respect to the boundary. The angular deviation of the neutrons during their interaction with the nuclei was not taken into account; as a result of this, insufficient data were obtained concerning the space-energy distribution of the secondary particles for the case of the interaction of high-energy nucleons with the nuclei. Passage of the neutrons through the shield is defined by the most energetic component of the spectrum, deflected at small angles. The differential emission of cascade protons at E_p = 460 Mev was measured by using the derived equations. Determination of the dependence of the neutron flux formed by the bombardment of a Be target with 660-Mev protons on the thickness of a steel or iron shield showed that at thicknesses larger than 20 cm the theoretical and experimental data agree quite well; the theoretical and experimental half-value attenuations, $\Delta_{1/2}$, were 15.9 ± 0.6 and 16.5 ± 1.3 cm, respectively. (TTT)

4687 PROTECTION AGAINST IONISING RADIATION. Jaroslav Slaba and Vladimir Potucek. Canadian Patent 656,998. Feb. 5, 1963. Filed Nov. 20, 1957.

A building material which gives protection against radiation comprises a carrier and a waste material from lead processing treatments. The carrier may be cement, ceramic material, or paper pulp, and the waste material may be sifted lead sweepings, oxidized lead dusts, or green uncalcined pyrites. The final product may be in the form of plastering, ceramic tiles, or constructional panels. (D.L.C.)

REACTOR TECHNOLOGY

General

4688 (BNL-799(p.1-25)) REACTOR PHYSICS DIVISION. J. Chernick and H. Kouts (Brookhaven National Lab., Upton, N. Y.).

Theoretical research was mainly in the fields of neutron thermalization and reactor dynamics. The analysis of the asymptotic characteristics of the uranium plate lattices was completed with excellent agreement between buckling measurements and the theory. Alternate cadmium ratio techniques of determining resonance capture in lattices were compared. A new uranium–graphite assembly was brought critical in the Minimum Reflection Critical Facility. Kinetics of the High Flux Beam Reactor were investigated. Measurements in uranium slabs in water were completed. For the Settled Bed Reactor program, uranium carbide fuel was analyzed. The characteristics of the settled bed are studied. Work is continuing on the magnetohydrodynamic systems as alternatives to the SNAP turbogenerators for generating electricity. Pulsed fission plasma reactor studies have indicated that UBr_3 or UBr_4 would be much more suitable gaseous fuels than UF_6 because of their lower disassociation temperatures. The characteristics of a thermally regenerated cell utilizing the $Pb–PbBr_2–Br_2$ system are being investigated. A study of the characteristics of a boiling oxygen chemonuclear reactor for ozone production was carried out. The feasibility study of gaseous-moderated reactors was continued and a number of cases using HF, CF_4, DF, and $HF \cdot CF_4$ moderators with UF_6-fueled cores were investigated. Studies of the stability of selected condensed aromatic compounds to heat, gamma radiation, and reactor radiation are continuing. Fouling tests are evaluated for organic coolants. Neutron and reactor cross section studies are reported. (N.W.R.)

4689 (BNL-799(p.101-3)) ENGINEERING DIVISION. T. V. Sheehan (Brookhaven National Lab., Upton, N. Y.).

The thermal shield for the High Flux Beam Reactor was installed and the dome was completed. The revised critical assembly is in operation. The revised mercury heat transfer loop is in operation. The new test section for the sodium–potassium heat transfer loop is under construction. Field erection of the boiling potassium heat transfer loop has begun. The design and testing of the chemonuclear loop is continuing. Field erection of the natural circulation boiling sodium loop has begun. The design of the pumped boiling sodium loop is continuing. Design and construction of equipment for the $UO_2–ThO_2$ lattice experiment is continuing. The construction of the SBR in-pile capsule experiment is 80% complete. (N.W.R.)

4690 (CONF-243-21) THE EDUCATION, EXPERIENCE, TRAINING, AND CERTIFICATION OF REACTOR OPERATORS AT AEC-OWNED REACTORS. Walter S. Wilgus, Whittie J. McCool, and Martin B. Biles (Division of Operational Safety, AEC). [nd]. 17p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Results of a questionnaire survey are presented on reactor supervisor and operator education, experience, and training, and on certification procedures by reactor category. The questionnaires were obtained from 362 supervisors, 393 operators, 44 supervisor trainees, and 139 operator trainees. (D.L.C.)

4691 (CONF-243-24) SELECTION OF PERSONNEL FOR REACTOR OPERATOR TRAINING. F. H. Martens (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 7p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The hiring practices and experiences of the Reactor Operations Division of Argonne are reviewed relative to the highest level of personnel who will remain on the job with an acceptable level of turnover. Men who have a bachelor's degree or who are close to receiving such a degree are not hired, since they usually leave after a short time. Men are hired who fall in one of three general categories: (1) graduates of two-year technical institutes, (2) men with experience in related operating jobs such as in the petroleum and chemical industries, and (3) men who have served in the nuclear programs of the armed forces. Pre-employment tests are described. (D.L.C.)

4692 (EURAEC-892) QUARTERLY PROGRESS REPORT NO. 1 [ON BWR STABILITY]. Lynn E. Weaver (Arizona. Univ., Tucson. Engineering Research Lab.). [1963]. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (11-1)-1311. 52p.

In the solution to the problem of minimizing boiling reactor noise through external control, there appears to be four possible methods of approach: optimum filtering, minimization of the reactor close loop bandwidth, gain scheduling, and adaptive control. Each of these methods is discussed. The work completed is concerned with the application and relative merit of methods one and two. In applying these techniques the reactor was described by a transfer function obtained from experimental data on operating boiling water reactors. Calculations show that considerable reduction of reactor noise can be realized through external control, the limiting factor being the physical realization of the control system corresponding to the mathematical models derived. To incorporate physical limitations into the control system design, constraints are placed on the system. In Method 1 saturation is considered to be the prime limiting factor, and in Method 2, the mean squared value of the reactor noise is used as a limiting factor. The difficulty in realizing the optimum control system is a function of the constant level. (auth)

4693 SECURITY PROBLEMS IN NUCLEAR REACTOR EXPERIMENTS. J. Laîère. Energie Nucl., 5: 406-11 (Sept.-Oct. 1963). (In French)

The experiments are grouped in four categories: radioelement production, experiments in exit-beam holes, coolant irradiation without self-contained circulation, and sample tests in loops. The risks of each category are studied together with the security parameters whose evolution reveals operation incident (temperature, pressure, flow rate, activity). The fourth and most complex case dealing with loop tests on fissile samples, is developed: preventive measures; detection systems for risk prediction; and reactor operation control using the above-mentioned parameters. (auth)

4694 DETERMINATION OF THE PROMPT NEUTRON PERIOD FROM THE FLUCTUATIONS OF THE NUMBER OF NEUTRONS IN A REACTOR. L. Pál (Central Research Inst. for Physics, Budapest). J. Nucl. Energy, Pt. A & B, 17: 395-409(Nov. 1963).

A detailed mathematical analysis is given of the prompt neutron period measurement based on the fluctuation of the number of neutrons in a reactor. In the case of the Feynman method the effect of the delayed neutrons on the accuracy of the measurement is investigated and the correlation between the numbers of neutrons counted in consecutive time intervals is examined so as to make possible appropriate choice of the conditions of measuring. For the Rossi method a general theory is developed taking into account the role of the delayed neutrons. It was found that the Rossi method can be used in the case of thermal reactors provided the average neutron lifetime is not longer than about 10^{-4} sec. Mogilner's zero probability method is discussed and the theoretical basis of this method is given. A new method (differential method) is proposed that is less sensitive to the correlation than the Feynman method. The Rossi and Mogilner methods proved to be faster and more reliable than the other two methods. (auth)

4695 PERCENTAGE OF HIGH BOILERS IN ORGANIC MODERATOR-COOLANTS. C. G. Pinchera and M. Cumo. Riv. Ing. Nucl., 1: 69-73(Mar.-Apr. 1963). (In Italian)

The increase of the percentage of high boilers in organic substances decreases the rate of radiolytic decomposition and worsens the thermal exchange characteristics. The problem is reexamined in the light of the best knowledge available at present to establish whether the 30% generally adopted actually represents the better compromise between the two tendencies for an organic-moderator reactor. A reactor cooled by forced convection only is considered. The results of the calculations indicate the advantage of decreasing the percentage of high boilers in moderator-coolants. (tr-auth)

4696 TIME OPTIMUM CONTROL OF NUCLEAR REACTORS WITH VELOCITY LIMITED CONTROL DEVICES. Thomas Patrick Mulcahey. Thesis, Lafayette, Ind., Purdue Univ., 1963. 188p.

A time optimum automatic controller was devised for a nuclear power reactor that should be consistent with the safety policies of the Atomic Energy Commission. An automatic controller designed to be fail-safe and time optimum in its response is then justified as being economic if its presence manages to eliminate one serious accident that might otherwise have occurred or if better utilization of the power plant is obtained. Since there is no single controller that will give optimum response to all reactor systems, a particular model of a reactor is established. It is based on the EBR-II fast reactor power system. The model developed assumes a coolant flow rate that is approximately linear with power. The resultant power reactivity feedback then assumes the approximate form of the natural logarithm of the power. The model of the control devices assumes a ramp rate of reactivity insertion for power level changes. In order to establish the method of operation of the desired controller, three main methods of analysis were used. The first involves the analytical solution to the fast reactor kinetics equations with one group of delayed neutrons and a feedback proportional to the natural logarithm of the power. The second method involves the analog computer simulation of the six group delayed neutron kinetics equations with feedback. The effects of feedback delay time constants were investigated with this method. The third method consisted of the solution of the one group and six group delayed neutron kinetics equations with feedback by use of a digital computer. This method is used as a measure of the range of validity of the analytical solution and as a means of improved accuracy over the analog computer. The results that were obtained from the analyses indicate that the one group analytical solution is able to predict the final power levels for a particular transient and, as such, it could be used to obtain design information for an optimum controller which uses as its basis of operation the measurement of elapsed time. The six group solution methods not only predict the final powers but the transients and, as such, should be the methods used in producing the information necessary for a design of an optimum controller that uses as its basis of operation the measurement of power level. For reasons of safety, it was concluded that the power level based controller is the one that should be adopted, thus the methods involving the six group delayed neutrons were used to establish characteristic per cent overshoot values. (TCO)

4697 HIGHLY SELF-SHIELDED BURNABLE POISONS. Richard Jacob Holl. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 133p.

A new burnable poison concept is proposed and evaluated for use in nuclear reactors. The unique features of the concept are the use of an element with a very high neutron capture cross section as poison material and the utilization of the microscopic self-shielding factor of individual poison disks. The large cross section allows the poison to be highly self-shielded over most of its design lifetime and still to burn out rapidly at the end-of-life. The large cross section also provides high spatial self-shielding with small particle sizes (on the order of 100 microns for the poison selected). This allows the poison particles to be dispersed either in the fuel material or in another material as a discrete poison element. With disk geometry having a large diameter-to-thickness ratio and high initial self-shielding, neutron capture by the poison causes only a small decrease in the effective cross section of the disk until nearly full depletion. Thus, the endurance of the burnable poison (irradiation lifetime) is determined by the thickness of the disk. The rate of decrease of the effective cross section with irradiation, for a constant thickness, is determined by the diameter-to-thickness ratio. Any decreasing curve for the burnable poison's effective cross section can be approximated by selection of the appropriate disk dimensions. Better approximations can be made by using mixtures of several disk sizes. After reviewing the potential elements that could be used as the burnable poison, gadolinium was selected as most promising. The only significant uncertainty found was the possible presence of an excessive poison residue (poison cross section remaining at the end of the design irradiation lifetime) due to the unknown cross section of gadolinium-156. An evaluation of the performance of natural gadolinium as the burnable poison material indicated that a thermal cross section of less than 1000 barns was required for the 156 isotope. A review of cross section measurements for gadolinium indicated that this upper limit for the 156 cross section was probable. A measurement of the reactivity of an irradiated sample of natural gadolinium, in which most of the high cross section material was burned out, was made to determine the poison residue. Attributing this residue to gadolinium-156 gave an effective thermal cross section of 300 ± 300 barns for the isotope. This is sufficiently low to establish the feasibility of using gadolinium as the burnable poison element. Self-shielding factors are given for gadolinium

metal disks of varying dimensions in several thermal neutron spectra. Measurements were made of the self-shielding factors for a set of disk sizes. The calculated and measured values were in satisfactory agreement. The effective poison cross sections versus irradiation are given for a range of disk sizes. A measurement for a single disk size following a nominal irradiation (nvt = 6×10^{19}) was made. This was in good agreement with the predicted value. Although this provides some support for the model employed for the calculations, additional measurements of irradiated samples are recommended. The effects of using the burnable poison on the temperature coefficient and temperature defect of the reactor were calculated. It was found that the temperature defect caused by the poison partially offsets its usefulness in holding down excess reactivity. The temperature coefficient due to the poison has the potentially useful characteristic of being negative and large at low temperature, decreasing in magnitude with increasing temperature, and finally becoming positive at high temperature. The final result is that the burnable poison concept should be able to be employed advantageously in many thermal reactor designs. (Dissertation Abstr., 24: No. 4, Oct. 1963)

4698 BOILING IN REACTORS. ITS DETECTION AND QUENCHING BY PERIOD METERS. W. H. McCorkle (Ames Lab., Ames, Iowa). 18p. (CONF-243-11)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The effects of boiling in the Borax-I and the EBWR are reviewed and compared to the boiling in the core of a research reactor such as CP-5 or ALRR. Boiling in a single fuel assembly of some reactors can affect a reactor period meter sufficiently to shut down the reactor and quench the boiling before fuel burnout occurs. (auth)

4699 CORE HANDLING IN HEAVY WATER REACTORS. Bernt T. A. Hargoe and Anton I. Holtz (to Aktiebolaget Atomenergi). Canadian Patent 669,874. Sept. 3, 1963. Priority date Dec. 7, 1959, Sweden.

A process for core handling in a shutdown heavy water reactor is described which is simple and minimizes heavy water loss. The process comprises drawing off the heavy water from the core while spraying heavy water over the fuel elements, spraying light water over the fuel elements to wash out the rest of the heavy water, filling the reactor with light water, replacing the core, and reversing the above operations to wash out the light water and to fill the reactor with heavy water. A pipe system for carrying out the process is described. (D.L.C.)

Auxiliaries and Components

4700 THE EFFECT OF REFLECTORS MADE OF VARIOUS MATERIALS ON THE INCREASE OF THE NEUTRON CAPTURE WITHIN THE URANIUM SHIELD OF A FAST-NEUTRON REACTOR. V. I. Golubev, A. V. Zvonarev, M. N. Nikolaev, and M. Yu. Orlov. At. Energ. (USSR), 15: 258-9(Sept. 1963). (In Russian)

It was found expedient to surround the fertile region of a fast-breeder reactor with a supplementary reflector, in order to reduce the neutron leakage. The material of this reflector must have a high scattering cross section and a relatively low absorption cross section while possessing satisfactory moderating and technical properties, without being unduly expensive. The problem was experimentally investigated with the BR-1 reactor. The changes in the number of neutron captures in the fertile zone as the supplementary reflector attached to the depleted U shield was changed were determined. The effect of the various materials was compared at the so-called "asymptotic spectrum" region (A. I. Leĭpunskiĭ, Atomn. Energ., 5: 277 (1958)). Layers of various thicknesses of Ni, Fe, Cu, stainless steel, Be, and water were placed next to the 57-cm thick U^{238} shield and the radiative neutron capture density near the boundary was determined by the β activity of U^{239}; the decay and fission products were removed chemically before the measurements. It was found that Fe is the least suitable material because of the deep interference dips in its cross section curve in the resonance energy range. Addition of other elements to the Fe, as in the case of stainless steel, results in the coalescence of the dips, making the alloy more suitable for use as a supplementary reflector. Ni and H_2O were found to be satisfactory, as they reduced the leakage by a factor of 2. As expected, Be was found to be the best material, but its high cost is a limiting factor. (TTT)

4701 ORGANIC FLUIDS AS MODERATORS AND COOLANTS IN THE NUCLEAR INDUSTRY. R. Degain. Energie Nucl., 5: 431-40(Sept.-Oct. 1963). (In French)

Organic fluids arouse interest as moderators and coolants in nuclear reactors. Elaborate chemical and physicochemical studies, together with highly efficient technological tests, are necessary before these fluids can be used on a large scale. The "organic" reactor seems to be one of those that should render nuclear power economically competitive. (auth)

4702 ANALOG STUDY OF THE TEMPERATURE CONTROL OF A NUCLEAR REACTOR WITH MOTION OF THE BAR REALIZED BY MEANS OF A CONSTANT SPEED MOTOR. F. Genovesi and C. Zaffiro. Riv. Ing. Nucl., 1: 74-82(Mar.-Apr. 1963). (In Italian)

A circuit for the temperature control of a reactor in which the control device of the control rod consists of a constant speed motor operated across an apparatus of the "on-off" type was examined and studied by means of an analog computer. The effects obtained with the reactor and motor in counter-reaction with anticipatory circuits and with passive networks of the RC type were studied. The control circuit can be optimized by selection of the values of the constants characterizing the counter-reaction network. A theoretical interpretation was given of the results obtained. (tr-auth)

4703 ANALYSIS OF PERIOD INSTRUMENTATION OPERATION AT FULL REACTOR POWER. Kenneth A. McCollom (Ames Lab., Ames, Iowa). 20p. (CONF-243-16)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

An analysis is made of the response time of period circuitry for application to power reactors so that the protection offered the reactor can be determined. Period instrumentation can be designed that will offer faster protection at full power reactor operation than the linear power scram system. Purposely lengthening the derivative circuit in the period instrumentation can eliminate this time advantage. It is possible to reduce statistical fluctuations by increasing the capacitance at the input, rather than varying the derivative time constant, since it is negligible in its effect at its present value. To allow interpretation of the protection obtained, it is necessary to hypothesize the type of accident for which protection must be obtained and deter-

mine if the additional response is required. It should only be warned that every possible condition must be considered before any time delay is added to assure that the safety protection of the reactor has not been reduced. (auth)

4704 PRESSURE TUBE INSPECTIONS IN-PILE. H. P. Koehler (Hawker Siddeley Canada Ltd., Toronto), and P. A. Ross-Ross. 44p. (CONF-243-10; AECL-1845).

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Equipment was developed to make possible the inspection of diameter, straightness, surface defects, and wall thickness of reactor pressure tubes without removing them from the reactor. Inspections are carried out wholly from the inside of the pressure tube by mechanisms which reach through the biological shielding. Access is provided only during reactor shut-down by opening the closure, defuelling and draining the pressure tube. (auth)

4705 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT CHARGING ARRANGEMENTS. (to Societe Indatom). British Patent 940,572. Oct. 30, 1963. Priority date Mar. 27, 1959, France.

A device to prevent fuel elements from being displaced during handling by the circulation of pressurized coolant fluid is patented. The device, located in the movable loading arm, consists of a thermocouple or flowmeter to measure the coolant flow in the fuel element channel and a means for injecting a counterflow of fluid into the channel to regulate the coolant flow. Details of the design of the movable loading arm and the control device are described. (M.P.G.)

4706 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CONTROL DEVICES. William Paul White and Keith Guy Eickhoff (to United Kingdom Atomic Energy Authority). British Patent 940,586. Oct. 30, 1963. Filed May 17, 1961.

A control element for emergency control of a reactor with vertical channels is patented. The element consists of discrete bodies of neutron-absorbing material linked together to form a flexible chain. The chain is held in a compact form but can be released to fall under gravity to a dispersed position of greater neutron-absorption capacity. The bodies may be in the form of plates loosely hinged together or hollow cones connected by flexible wires. (M.P.G.)

4707 FUEL ELEMENT CHARGING ARRANGEMENTS FOR NUCLEAR REACTORS. (to Societe des Forges et Ateliers du Creusot). British Patent 940,734. Oct. 30, 1963. Priority date Mar. 9, 1959, France.

An improved control mechanism for a reactor-fuel-element-charging apparatus is patented. The charging apparatus is of the type having an axial tube and a tubular arm on the tube, which connects to any one of many fuel element channels by rotation of the axial tube and movement of the tubular arm about an axis transverse to the axis of rotation. The control mechanism secures the various movements of the movable elements of the charging apparatus so that the lower end of the tubular arm is brought opposite the top orifice of the selected fuel channel. The design of the control mechanism and the charging apparatus is described and diagramed in detail. (M.P.G.)

4708 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Ivor Kent, Peter Waine, and Gordon Packman (to United Kingdom Atomic Energy Authority). British Patent 940,743. Oct. 30, 1963. Filed June 17, 1959.

A temporary storage facility for reactor fuel elements within the reactor shield is patented. The facility consists of one or more chambers in the reactor shielding accessible from the reactor charge face. A closed-circuit fluid-flow system is provided in the facility for cooling or heating stored fuel elements. The design of the storage chamber and cooling system is described. (M.P.G.)

4709 NUCLEAR REACTORS. Didier Costes, Noel Laurent, and Alphonse Peuchmaur (to Commissariat a l'Energie Atomique). British Patent 940,759. Oct. 30, 1963. Priority date May 27, 1961, France.

The design of a nonreturn device is patented, which prevents fuel elements from moving back after they have been inserted into a reactor channel. The device consists of resilient arms on a radially expanding thimble housed in a counterbore of the channel wall. The resilient arms are bent toward the axis of the channel and close over the fuel element after it has been inserted to prevent it from moving out. The device has a small diametral size, is of simple construction, and provides absolute safety. Details of the design are described. (M.P.G.)

4710 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUELLING ARRANGEMENTS. Peter Thomas Hilliard, Kenneth Thomas Peers Langdon, and William Robert Wootton (to Babcock and Wilcox Ltd.). British Patent 940,919. Nov. 6, 1963. Filed July 11, 1961.

A machine for refueling gas-cooled reactors is described. The machine composes a biological shield, pressure vessel, and magazine for irradiated fuel elements. The reactor, to which the machine is applied, consists of upright fuel channels enclosed in a pressure vessel. The fueling machine provides for transport of fuel elements disposed within the pressure vessel above the level of the top of the core, downwardly extending shafts through which fuel elements may be passed, and locating means for selective positioning of the machine with respect to the core. (R.E.U.)

4711 IMPROVEMENTS IN MACHINES FOR LOADING AND UNLOADING THE CHANNELS OF A NUCLEAR REACTOR. Alphonse Peuchmaur, Pierre Canet, and Claude Gillieron (to Commissariat à l'Énergie Atomique). British Patent 941,600. Nov. 13, 1963. Priority date Aug. 16, 1961, France.

The frame of the machine is guided so as to move parallel to the free face of a reactor. A longitudinal passage, parallel to the reactor channels, is provided with an outer tube slightly smaller in diameter than the channel end portion and equal in diameter to the channel central portion. This tube slides in the passage from complete retraction to an inserted position in the fuel channel. The tube is provided with a hooking means and also an inner rod of slightly smaller diameter than the central channel which is extendable into the central portion of the fuel channel. It is also provided with a means for hooking of fuel elements. Means for storage of the extracted fuel elements is also provided. (R.E.U.)

4712 IMPROVEMENTS RELATING TO SAFETY DEVICES FOR NUCLEAR REACTORS. Charles Theodore Geeson (to A. Reyrolle & Co., Ltd.). British Patent 941,678. Nov. 13, 1963. Filed Nov. 10, 1958.

A safety device for the control of gas-cooled reactors is described. The neutron-absorbing control rods are lowered vertically into passages between the fuel channels by a suitable transmission mechanism automatically in response to an abnormal condition in the reactor pressure vessel. The device operates independently of the normal electrical

safety circuits in the reactor control system by means of release mechanism on the clutch of the lowering transmission. (R.E.U.)

4713 IMPROVEMENTS IN OR RELATING TO ENERGY DISSIPATION DEVICES. Gordon Brown and Arthur Firth (to United Kingdom Atomic Energy Authority). British Patent 942,157. Nov. 20, 1963. Filed Apr. 25, 1961.

A device for use in nuclear reactors to dissipate energy from falling bodies such as control rods or fuel elements to prevent the creation of excessive impact forces in the falling bodies is described. The energy dissipator has a latch capable of holding it against displacement out of the reactor by coolant flow through the reactor. The latch has two parts, one engageable with the other. The parts are readily engageable, but are disengageable only by stressing the latch until the part attached to the device deforms plastically to release the latch while the part attached to the reactor structure remains underformed. (M.C.G.)

4714 NUCLEAR REACTOR FUEL ELEMENT CHANGING ARRANGEMENTS. (to Sulzer Freres, Societe Anonyme). British Patent 942,277. Nov. 20, 1963. Priority date Feb. 12, 1960, Switzerland.

A reactor that permits simplification of the mechanical apparatus required to remove and replace fuel elements disposed in moderator apertures and connected to coolant pipes is described. The coolant pipes and the fuel element handling apparatus are disposed on opposite sides of the moderator block. The handling apparatus and provisions are explained, and several embodiments are considered. (D.C.W.)

4715 MANIPULATING DEVICES FOR ACTUATING SECURING DEVICES FOR FUEL ELEMENTS IN NUCLEAR REACTORS. (to Sulzer Freres, Societe Anonyme). British Patent 942,290. Nov. 20, 1963. Priority date June 8, 1960, Switzerland.

A manipulating device for actuating securing devices for fuel elements in a nuclear reactor in which rod-like fuel elements are disposed in a moderator unit and the fuel elements are connected to pipe connections mounted in the securing devices and through which coolant flows. The apparatus consists of a traveling assembly of concentric relatively movable tubes that have at one end loops adapted to engage or co-operate with any selected securing device and which are operated from the other end of the tube assembly, which is shielded from radiation at the tool end. (M.C.G.)

4716 IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ELEMENT HANDLING DEVICES. John Anthony Collis-Smith, Joseph Ralph, and Reginald William Creear (to The English Electric Co. Ltd.). British Patent 942,314. Nov. 20, 1963. Filed June 4, 1959.

A transfer device for servicing the fuel element channels of a reactor is described. It consists of a main transfer tube, a movable transfer tube with a free end, and a disengageable drive means adapted when engaged to automatically move the movable tube between a nested position within the main tube and at least one position in which the free end is spaced transversely from the axis of the main tube in response to rotation of the device as a whole about its axis. (M.C.G.)

4717 IMPROVEMENTS IN OR RELATING TO CONTROL SYSTEMS FOR NUCLEAR REACTORS. Sydney Fawcett and Ronald Hugh Campbell (to United Kingdom Atomic Energy Authority). British Patent 942,319. Nov. 20, 1963. Filed July 6, 1960.

A reactor with a shut down system activated through an electrical circuit from an apparatus sensitive to predetermined variations in reactor performance is described. Provisions are included for short circuiting, without loss of response to the abnormal variations, to permit routine testing of the control facilities with the reactor on load. (D.C.W.)

4718 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Rene Donguy and Jean Megy (to Commissariat à l'Energie Atomique). British Patent 943,496. Dec. 4, 1963. Priority date Oct. 3, 1959, France.

A matrix system for sampling the coolant in fuel rod channels of heterogeneous reactors to locate faults in fuel casings is described. The system permits a more rapid identification of the defective channel, while requiring only a single detector. Provision is made for balancing the outputs of the sampling pipes. (D.C.W.)

4719 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR INSERTING AND REMOVING CAPSULES OF SAMPLES INTO AND FROM AN IRRADIATION CHANNEL OF A NUCLEAR REACTOR. Gabriel Guyon (to Commissariat à l'Energie Atomique). British Patent 943,657. Dec. 4, 1963. Priority date Apr. 26, 1960, France.

A simple apparatus for charging and discharging samples into and out of an irradiation channel without shutting down the reactor, while maintaining adequate biological protection, is described. Samples can be irradiated at any time and for any desired period. (D.C.W.)

4720 SAFETY DEVICE FOR NEUTRONIC REACTOR. Werner Spillmann (to Escher Wyss AG). Canadian Patent 658,123. Feb. 19, 1963. Priority date Sept. 7, 1959, Switzerland.

A safety device using a neutron-absorbent gas, e.g., BF_3, is designed for gas-cooled reactors. The BF_3 vessel of the safety device is located in the coolant outlet and has at least one pipe opening into the coolant inlet. The mouth of the pipe has a closure member which opens when a predetermined gas pressure in the vessel is exceeded. In the event of excessive heat generation in the reactor, the coolant temperature at the outlet rises, increasing the pressure in the BF_3 vessel and thus causing the BF_3 to escape into the let to stop the reaction in a very short time. (D.L.C.)

4721 SAFETY DEVICE FOR THE BASE DISCHARGE OF A VERTICAL CHANNEL OF A NUCLEAR REACTOR. Sébastien Foglia (to Commissariat à l'Énergie Atomique). Canadian Patent 661,016. Apr. 9, 1963. Priority date Feb. 10, 1959, France.

A device is designed for the emergency discharge by gravity from the base of a vertical channel in a reactor soon after the detection of fuel element failure. The device comprises a support permanently fixed to the moderator and leaving free the outlet of the channel, a member disposed across the channel and locked on the support, means for supporting the fuel elements, and a zone of weaker mechanical resistance allowing the member to be cut and so free the base of the channel. The support is not damaged when the member is cut. (D.L.C.)

4722 DEVICES FOR DETECTING FISSIONABLE MATERIAL JACKET BURSTS IN NUCLEAR REACTORS. André Roguin and René Donguy (to Commissariat à l'Énergie Atomique). Canadian Patent 667,743. July 30, 1963. Priority date Nov. 13, 1959, France.

A device is designed for detecting fuel jacket bursts in a gas-cooled reactor. Bursts are detected by allowing the short-lived fission products in the coolant samples to decay into positive ions, collecting the ions on a movable metal

drum, and moving the drum so that successively different sectors thereof are brought opposite a detector. The sensitivity of the device is increased by the following features: the decay and ion formation chamber has an aperture which is closed in a gastight manner by a portion of the periphery of the drum, constituting a collecting area; the drum is given both a translatory and a rotatory movement for scanning of its periphery portions by the detector. (D.L.C.)

4723 METHOD AND APPARATUS FOR DETECTING FAULTS IN THE CASINGS OF FUEL RODS EMPLOYED IN A NUCLEAR REACTOR. René Donguy and Jean Mégy (to Commissariat à l'Énergie Atomique). Canadian Patent 669,845. Sept. 3, 1963. Priority date Oct. 3, 1959, France.

An apparatus for detecting fuel jacket failures in a reactor is designed which uses a matrix system. The apparatus comprises a system of tubes for sampling the coolant from the channels, and the tubes are arranged in a square matrix and connected with collectors in such a way that the coolant in any one row of tubes is fed to a single collector while the coolant in any one column of tubes is fed to another collector. Thus, it is possible to identify the faulty channel by inspecting the row and column collectors with detectors through selector means. (D.L.C.)

4724 ASSEMBLY OF SOLID MODERATOR ELEMENTS FOR HIGH TEMPERATURE NUCLEAR REACTORS SUBJECTED TO ACCELERATIONS. Gilbert Mission and Henri Meulien (to Société Nationale d'Étude and Construction de Moteu d'Aviation). Canadian Patent 669,872. Sept. 3, 1963. Priority date Dec. 4, 1959, France.

A solid moderator is designed for a high-temperature, high-pressure gas-cooled reactor which is subjected to sudden movements, e.g., in movable vehicles. The moderator comprises an assembly of parallel moderator columns in stack form, each having an axial channel for receiving fuel elements and for circulating the coolant. The columns are mutually independent and can expand laterally by reason of clearances between adjacent columns and axially by reason of resilient guide (spring) means. The supports at each end of the columns are maintained at a low temperature so that only the columns themselves are subjected to high temperatures. (D.L.C.)

4725 METHODS AND DEVICES FOR DETECTING THE PRESENCE OF FISSION PRODUCTS IN THE COOLANT FLUID STREAMS OF A NUCLEAR REACTOR. René Donguy and Jean Mégy (to Commissariat à l'Énergie Atomique). Canadian Patent 670,698. Sept. 17, 1963. Priority date Dec. 2, 1959, France.

A device for permanently supervising the radioactivity level in coolant streams in order to detect possible fuel can bursts is designed which uses a reduced number of conduits, switching elements, and detectors. The channels are grouped into square matrixes each of n lines and n columns, and the sampled coolant is collected in line collectors and column collectors. A single line channel and a single column channel are provided with a line detector and a column detector, and switching and controlling means are used to feed the line and column outputs successively to their detectors. (D.L.C.)

4726 ARRANGEMENT FOR DETECTING RADIATION CONTAMINATION OF THE COOLANT IN AN ATOMIC REACTOR. Roland Cochinal, André Roguin, and René Donguy (to Commissariat à l'Énergie Atomique). Canadian Patent 672,193. Oct. 15, 1963. Priority date Mar. 28, 1958, France.

An arrangement is designed for detecting damage in fuel rod sheaths in gas-cooled reactors. In this arrangement, the ducts are connected in a gas circuit in sets and the sets in turn are connected in groups, and a detector and a supervisory detector are provided for each group. Valve means, automatic switch means, and a timer are provided so that when an anomaly is found in a set by the detector, the set is connected to the supervisory detector while the other sets continue to be monitored by the first detector. (D.L.C.)

4727 CONTROL OF NEUTRONIC REACTOR. Werner Spillmann (to Escher Wyss AG). Canadian Patent 673,576. Nov. 5, 1963. Priority date Sept. 19, 1959, Switzerland.

A device for the control of a reactor is designed which affects the neutron flux in a uniform way and does not require much space outside the core for withdrawal of the control elements. The device comprises at least one pair of control elements arranged on opposite sides of the reactor and coupled together so that on operation of the device, they move simultaneously in opposite directions. The control elements may comprise rods or an articulated series of small containers filled with a neutron absorber, and the coupling means may comprise cables or chains. (D.L.C.)

4728 SCINTILLATING DEVICE FOR MEASURING THE CONCENTRATION OF GASEOUS-PHASE FISSION PRODUCTS. André Roguin (to Commissariat à l'Énergie Atomique). Canadian Patent 674,084. Nov. 12, 1963. Priority date June 2, 1960, France.

A measuring device for detecting short-lived fission products in e.g. coolant samples from a reactor channel, is designed which reduces the noise level due to long-lived radioactivity. The device comprises a movable electrode located on a piston arranged to move in an insulating cylinder around which is provided a fixed annular repulsion electrode, a scintillator in the upper portion of the clyinder, and channels for passing gas into and out of the cylinder. In the operation of the device, the piston is lowered, gas is passed into the cylinder and allowed to remain for a time sufficient to form radioactive ions which are then collected on the piston, and the piston is moved to abut the scintillator for measurement of the ions. (D.L.C.)

4729 CORE ELEMENTS FOR NUCLEAR REACTORS. Frank Sterry and George Edward Lockett (to United Kingdom Atomic Energy Authority). U. S. Patent 3,111,476. Nov. 19, 1963. Priority date May 14, 1958, Great Britain.

A means to prevent back-diffusion of fission products through the pores in the graphite moderator of cylindrical fuel elements is described. The rate of coolant diffusion through the graphite decreases more rapidly than that of the fission products so that an optimum point must be accepted. A coolant gas inlet plug of higher permeability than the container wall is described. This provides means for diluting the volatile fission products so that there is less diffusion in the coolant region where there is low fission-product concentration. (R.E.U.)

4730 EQUIPMENT FOR AUTOMATIC CONTROL OF AN ATOMIC REACTOR. Pavel Kovanic and Milan Kulka (to Zavody V.I. Lenina Plzen). U. S. Patent 3,112,253. Nov. 26, 1963. Priority date Feb. 18, 1958, Czechoslovakia.

An apparatus for automatic control of a reactor during startup is described. A detecting element is moved within the radiation field of the reactor in the direction away from the reactor at a speed corresponding to a desired program of reactor output variations. The output signal of the detecting element is compared with a predetermined demand signal to produce a control signal corresponding to the difference between the demand and output signals. The

control rods are moved successively to a predetermined maximum extent in response to the control signal so as to minimize it. (M.C.G.)

4731 APPARATUS FOR AUTOMATIC REGULATION OF THE PERIOD OF ATOMIC REACTORS. Pavel Kovanic and Milan Kulka (to Zavody V.I. Lenina Plzen). U. S. Patent 3,112,254. Nov. 26, 1963. Priority date Feb. 18, 1958, Czechoslovakia.

An apparatus for automatically controlling the period of reactors is described. A detecting element, which measures the radiation intensity of the reactor, is arranged for movement by a servo-drive mechanism controlled by a program source according to a desired control program. The output signal of the detecting element is fed to a reference circuit, including an amplifier, for comparison with a reference signal. The resulting differential signal is futher modified and amplified as may be required, and fed to the servo-drive of the control elements of the reactor, such as control rods, to cause movement of the control elements in a direction to cause a decrease in the differential signal. The reactor output thus varies in accordance with the movement of the detector element. When the detector element is moved along a path in which the intensity of the radiation varies exponentially with the position of the detecting element, the period of the reactor becomes a function of the velocity of the detecting element along that path. (M.C.G.)

4732 SHIELD FOR INTERCEPTING RADIANT ENERGY FROM AN ATOMIC REACTOR. Tibor F. Nagey, Stanley W. Burriss, Robert B. Spooner, and William A. Maxwell (to Martin-Marietta Corp.). U. S. Patent 3,113,089. Dec. 3, 1963. Filed Nov. 24, 1954.

A light-weight, low-density structural shield for interposition between a reactor and the operating personnel, especially an aircraft crew, is described. The shield consists of low-density cellular honeycomb material that has the property of absorbing radiation from the reactor. The voids in the cellular material are filled with liquids or solids also capable of absorbing radiation. (M.C.G.)

4733 LOGIC CIRCUIT. Grant H. Strong and Melvin L. Faught (to U. S. Atomic Energy Commission). U. S. Patent 3,115,451. Dec. 24, 1963.

A device for safety rod counting in a nuclear reactor is described. A Wheatstone bridge circuit is adapted to prevent de-energizing the hopper coils of a ball backup system if safety rods, sufficient in total control effect, properly enter the reactor core to effect shut down. A plurality of resistances form one arm of the bridge, each resistance being associated with a particular safety rod and weighted in value according to the control effect of the particular safety rod. Switching means are used to switch each of the resistances in and out of the bridge circuit responsive to the presence of a particular safety rod in its effective position in the reactor core and responsive to the attainment of a predetermined velocity by a particular safety rod enroute to its effective position. The bridge is unbalanced in one direction during normal reactor operation prior to the generation of a scram signal and the switching means and resistances are adapted to unbalance the bridge in the opposite direction if the safety rods produce a predetermined amount of control effect in response to the scram signal. The bridge unbalance reversal is then utilized to prevent the actuation of the ball backup system, or, conversely, a failure of the safety rods to produce the predetermined effect produces no unbalance reversal and the ball backup system is actuated. (AEC)

4734 COMPOSITE CONTROL ROD. H. R. Rock (to U. S. Atomic Energy Commission). U. S. Patent 3,115,452. Dec. 24, 1963.

A composite control rod for use in controlling a nuclear reactor is described. The control rod is of sandwich construction in which finned dowel pins are utilized to hold together sheets of the neutron absorbing material and non-absorbing structural material thereby eliminating the need for being dependent on the absorbing material for structural support. The dowel pins perform the function of absorbing the forces due to differential thermal expansion, seating further with the fins into the sheets of material and crushing before damage is done either to the absorbing or non-absorbing material. (AEC)

4735 EMERGENCY SHUTDOWN FOR NUCLEAR REACTORS. John Arthur Paget, S. L. Koutz, R. S. Stone, and H. B. Stewart (to U. S. Atomic Energy Commission). U. S. Patent 3,115,453. Dec. 24, 1963.

An emergency shutdown or scram apparatus for use in a nuclear reactor that includes a neutron absorber suspended from a temperature responsive substance that is selected to fail at a preselected temperature in excess of the normal reactor operating temperature, whereby the neutron absorber is released and allowed to fall under gravity to a preselected position within the reactor core is presented. (AEC)

4736 METHOD AND APPARATUS FOR EXAMINING FUEL ELEMENTS FOR LEAKAGE. Richard R. Smith, Maurice William Echo, and Charles B. Doe (to U. S. Atomic Energy Commission). U. S. Patent 3,116,211. Dec. 31, 1963.

A process and a device for the continuous monitoring of fuel elements while in use in a liquid-metal-cooled, argon-blanketed nuclear reactor are presented. A fraction of the argon gas is withdrawn, contacted with a negative electrical charge for attraction of any alkali metal formed from argon by neutron reaction, and recycled into the reactor. The electrical charge is introduced into water, and the water is examined for radioactive alkali metals. (AEC)

4737 REACTOR MODERATOR STRUCTURE. B. L. Greenstreet (to U. S. Atomic Energy Commission). U. S. Patent 3,116,214. Dec. 31, 1963.

A system for maintaining the alignment of moderator block structures in reactors is presented. Integral restraining grids are placed between each layer of blocks in the moderator structure, at the top of the uppermost layer, and at the bottom of the lowermost layer. Slots are provided in the top and bottom surfaces of the moderator blocks so as to provide a keying action with the grids. The grids are maintained in alignment by vertical guiding members disposed about their peripheries. (AEC)

Crititicality Studies

4738 (ANL-6681) A SURVEY OF PROMPT-NEUTRON LIFETIMES IN FAST CRITICAL SYSTEMS. G. S. Brunson, R. N. Curran, J. M. Gasidlo, and R. J. Huber (Argonne National Lab., Idaho Falls, Idaho). Aug. 1963. Contract W-31-109-eng-38. 65p.

Measurements of prompt-neutron lifetime in more than 30 different critical systems are reported. Most were assembled in ZPR-III. The method represents a direct experimental determination of the ratio $\Delta k_p/\tau_0$, from which a value for τ_0 is obtained if an estimate of Δk_p is available. Our results indicate that for these assemblies, the lifetime

is almost entirely governed by the uranium content of the core, and results on lifetime are related to an empirical parameter. Experiments are done to test the range of validity of the theory. It is found that in a large all-metal system, such as the mockup for the Enrico Fermi Fast Breeder Reactor, the value obtained for alpha does not appear to vary with the position of the counters in the core. From a measurement of the total coincidence probability as a function of the separation of the two counters it is found that the terminating counter was not necessarily most likely to detect a chain-related neutron when it was closest to the initiating counter. Rather, it was most likely to detect chain-related neutrons when it was in a position of highest flux, and further, this probability is, within the limits of experimental error, directly proportional to the flux in which the terminating counter is placed. In another assembly which had beryllium regions in the reflector it was found that the time distribution of coincidences at the center of the core was complex but could confidently be resolved into two decay periods. The larger alpha is interpreted as representing the time behavior of chain-related neutron pairs having no intervening events in the beryllium. The smaller alpha represents the time behavior of chain-related neutron pairs when at least one intervening event has occurred in the beryllium. When the terminating counter was placed in the beryllium, a single value for alpha was obtained which agreed with the smaller value found in the core. The disappearance of the fast decay in this case supports the hypothesis that the larger alpha is associated with the core composition. Further, an extension of theory gives a method of determining the reactivity of the fast system independent of the reactivity contribution of a moderating reflector. (auth)

4739 (CONF-187-14) MEASUREMENTS OF BUCKLINGS AND DIFFUSION COEFFICIENT CHANGES IN D_2O-MODERATED LATTICES OF TUBULAR UO_2 ASSEMBLIES. H. R. Fike and W. E. Graves (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Nov. 1963]. Contract AT(07-2)-1. 10p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Diffusion coefficients and bucklings are measured for UO_2 fuel tube assemblies in D_2O moderated lattices. The effects of H_2O fogs and air in the coolant channels in place of D_2O are studied. (T.F.H.)

4740 (CONF-187-24) BUCKLING MEASUREMENTS–HEAVY NATURAL URANIUM TUBULAR FUEL ASSEMBLIES. A. E. Dunklee and W. E. Graves (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Nov. 1963]. Contract AT(07-2)-1. 16p.

From American Nuclear Society Meeting, New York, Nov. 1963.

One-region buckling measurements that were made on a series of D_2O-moderated lattices of heavy uranium metal tubes in the Process Development Pile at Savannah River Laboratory are presented. The purposes of these measurements are to provide normalization points for lattice bucklings and to extend the study of natural uranium–D_2O systems. The dependence of buckling on the moderator-to-fuel ratio is studied for two types of lattices. (R.E.U.)

4741 (EUR-401.e) RECENT INVESTIGATIONS CONCERNING THE INFLUENCE OF NON-UNIFORM TEMPERATURE DISTRIBUTION IN DOPPLER EFFECT CALCULATIONS. G. Blaesser and W. Matthes (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 15p. (CONF-193-7)

From 8th Nuclear Congress, Rome, June 1963.

To study the influence of nonuniformities in the temperature distribution inside fuel rods, the Doppler coefficient has been calculated by direct integration of the narrow-resonance formulas for a single resonance for a slab lattice. Also, a Monte Carlo method has been developed that allows the calculation of the total temperature coefficient of non-uniformly heated fuel in the region of unresolved resonances; in this method the details of the resonance structure are determined by sampling from the statistical level and widths-distributions. Preliminary results of both theories are presented. (auth)

4742 (LADC-5845) POWER SPECTRUM MEASUREMENT AND THE ESTIMATION OF POWER SPECTRAL DENSITY. Ronald R. Mohler (Los Alamos Scientific Lab., N. Mex.). Nov. 4, 1963. Contract W-7405-eng-36. 42p. (CONF-332-2)

From Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963.

Statistical methods for indirectly computing the power spectrum and power spectral density of stochastic processes are discussed. Particular attention is given to nuclear-engineering applications. (T.F.H.)

4743 (WAPD-T-1623) EXPERIMENTS WITH A HIGH-SPEED FUEL DENSITY SEED-BLANKET CRITICAL ASSEMBLY. R. P. Christman, G. G. Smith, G. F. Bogar, and C. H. Rutherford (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT(11-1)-Gen-14. 20p. (CONF-187-22)

From American Nuclear Society Meeting, New York, Nov. 1963.

The design of long-lifetime seed-blanket cores creates a need for calculational-experimental physics comparisons on critical assemblies having a high seed-fuel density. Since experimental data are not available at high fuel densities, an experimental program is initiated to obtain parameters in a core having fuel densities varying from 282 to 449 g U-235/liter in the seed-fuel region. The comparison of experimental and calculational results show that a nuclear-design-type calculation predicts with comparable accuracy criticality, seed power peaking factors, and boron capture fractions at the given seed fuel densities. (auth)

4744 (WAPD-T-1627) LIMITATIONS OF THE INHOUR FORMULA. A. F. Henry (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT(11-1)-Gen-14. 18p. (CONF-187-18)

From American Nuclear Society Meeting, New York, Nov. 1963.

The use of a limited set of vectors $|\Psi_{nj}>$ to describe space-time transients is concluded to be valid for large, moderately uniform reactors. Certain sum rules, occasionally useful in transient analysis, are valid when an expansion in the $|\Psi_{nj}>$ is legitimate. For small or highly heterogeneous cores, however, there is a possibility that the parameters of the inhour formula may become so dependent on eigenvalue that the formalism loses its utility. (auth)

4745 FUEL ELEMENT BASED ON TEFLON-4 FOR CRITICAL ASSEMBLIES. N. N. Ponomarev-Stepnoi, S. S. Lomakin, and Yu. G. Degaltsev. At. Energ. (USSR), 15: 259-60(Sept. 1963). (In Russian)

The neutron-physical properties of the materials used in critical assemblies are usually quite close to those of the materials intended to be actually used in reactors under development. In mocking up homogeneous reactors in the

past, moderator blocks with homogeneously dispersed fuel were customarily used. However, this arrangement precludes a variation of the fuel concentration. A system was developed to eliminate this difficulty: the assembly is made from thin layers of moderator between layers of fuel; this heterogeneous system allows experiments to be carried out involving variation of the fuel concentration. Inasmuch as the presence of hydrogeneous materials is often undesirable, tetrafluoroethylene layers were used. In order to represent the fuel elements, U oxides were added to the polymer in form of filler. It was thus found possible to mock up nearly completely homogeneous systems. Exposure of the polymer which is a weak neutron absorber, to a total flux of 10^{13} n/cm^2, which is about 1000 times higher than the anticipated lifetime exposure of the elements, did not affect the physical properties of the material. The self-shielding coefficient was measured as a function of the U contained in the layer. The derived curve may be used for calculating the secondary fission neutrons with an accuracy of better than 2%. (TTT)

4746 THE INFLUENCE OF REFLECTORS MADE OF DIVERSE MATERIALS ON THE INCREASE OF THE NEUTRON CAPTURE IN A URANIUM CARBIDE FAST-REACTOR SHIELD. V. I. Golubev, A. V. Zvonarev, M. N. Nikolaev, and M. Yu. Orlov. At. Energ. (USSR), 15: 327-8 (Oct. 1963). (In Russian)

Following previous studies indicating that use of supplementary reflectors results in a considerable increase of the neutron capture in a metallic U breeding blanket, the effect of such reflectors in a U carbide blanket was investigated at the asymptotic neutron spectrum range. The measurements were carried out with the BR-1 reactor, provided with a shield of depleted U and graphite with a U:C ratio of 1:0.884, close to the composition of U carbide. A supplementary reflector made of Be, H_2O, Fe, Cu, Ni, graphite, or stainless steel was placed close to the shield. It was found that increasing the thickness of the graphite reflector beyond 600 mm or that of the Fe reflector beyond 184 mm does not result in a substantial increase of the number of captures within the shield. The experiment involved the measurement of the U^{238} neutron capture density in the reactor shield with and without the reflector. At the same time the radiative capture density distribution in the reinforced U carbide shield was also determined by means of the β activity of irradiated depleted U_3O_8 specimens. It was found that the efficiency of materials which soften the neutron spectrum, such as H_2O and Be, is strongly reduced when the U shield was replaced by a UC one, while the efficiency of heavy materials was only slightly affected; the efficiency of Fe was actually increased. (TTT)

4747 THE VOID EFFECT IN EK-10-TYPE FUEL ELEMENT ASSEMBLIES. Tamas Barta, Ferenc Szabó, Laszlo Turi, and Jozsef Vigassy. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 345-53(1963). (In Hungarian)

The effect on reactivity produced by the introduction of vertical empty channels into the critical assemblies ZR-1 and ZR-2 was measured. A brief discussion of the theory of the effect thus observed is followed by the description of the measurements and presentation of the results. (auth)

4748 CONCERNING THE INFLUENCE OF A PROMPT NEGATIVE TEMPERATURE COEFFICIENT ON THE BEHAVIOR OF A FAST REACTOR AFTER A REACTIVITY EXCURSION. Axel Fraude (Kernforschungszentrums Karlsruhe, Ger.). Nukleonik, 5: 290-3(Oct. 1963). (In German)

The nonlinear location-dependent dynamic equations were solved by analytic approximation in the region of reactivity excursions, for which the influence of the delayed neutrons and the negative temperature coefficient is totally or partly compensated. (tr-auth)

4749 ON SOME PROPERTIES OF THE REACTOR KINETICS INTEGRAL EQUATION: THE PERTURBED-KERNEL METHOD. Aldo Belleni-Morante (Università, Florence). Nukleonik, 5: 293-6(Oct. 1963).

The reactor kinetics integral equation, $n(t) = f(t) + \int_0^t K(t,v)n(v)dv$, was used to calculate the neutron density $n(t,p)$ when the multiplication factor is the form $k(t) = 1 + pk_1(t)$, where p is a parameter not too far from zero. (auth)

4750 METHOD FOR DIRECT REACTIVITY MEASUREMENTS. Wolfram Ziegler (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nukleonik, 5: 296-9(Oct. 1963). (In German)

Before nuclear reactors can go into operation, careful reactivity calibration, among other things, is necessary. If the periodic course of the neutron flux is evaluated with the help of an electronic analog computer, each time point of effective reactivity in the reactor can be determined without noticeable time delay. It was found that two methods may be used, the $\rho \cdot \phi$ equation and the ϕ equation. The first method is considered preferable in the literature. On the basis of accuracy and the universal applicability of the necessary analog computers it is nevertheless inferior to the method with ϕ equations. It is explained how the effects of temperature on total reactivity can be introduced or can be determined separately as a reactivity constituent. (tr-auth)

4751 STUDIES ON TRANSIENT HEAT TRANSFER IN THE HETEROGENEOUS WATER REACTOR. Shigenori Hayashi, Akira Sakurai, et al. (Kyoto Univ.). Tech. Rept. Eng. Res. Inst., Kyoto Univ., 13: No. 6, 1-21(May 1963).

Experimental studies were performed on the transient heat transfer between the fuel and the coolant when the reactor power is increased exponentially. Methods for applying the results to the analysis of reactor kinetics during a power excursion were also shown. The experiments showed a good agreement with the analysis. (auth)

4752 AN IMPROVED METHOD OF DOPPLER EFFECT CALCULATION FOR FISSILE MATERIALS IN THE INTERMEDIATE ENERGY REGION. R. N. Hwang. 27p. (CONF-334-2).

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

Two types of interference interactions in the intermediate energy region are discussed. The overlapping effect is attributed to the interaction of neighboring resonances of a particular fissile isotope. The second type is attributed to the interactions of resonances of two different isotopes in the mixture. The effect of these interactions gives rise to the change on the fine structure of the neutron flux and reduction in Doppler broadening. Calculations were made for U^{235} and Pu^{239} using previous methods and the dual-interference-interaction method. (R.E.U.)

Design and Feasibility

4753 (LAMS-2427) A RADIATION REACTOR CONCEPT (GLOWWORM). L. D. P. King (Los Alamos Scientific Lab., N. Mex.). Apr. 1963. Contract W-7405-eng-36. 49.

A reactor concept that uses radiation as the principal heat transfer mechanism between reactor core and heat exchanger is described. Calculations for spherical and cylindrical geometry are presented, together with preliminary studies of promising high temperature fuels. Possible applications for such a reactor and areas for future research and development are outlined. (auth)

4754 NUCLEAR REACTOR DUCT STRUCTURE. Lucien Alfille (to Commissariat à l'Énergie Atomique). British Patent 941,668. Nov. 13, 1963. Priority date Apr. 29, 1959, France.

Parallel ducts in a moderator core of a heterogeneous reactor are described. The ducts contain the fuel elements and also form part of the cooling circuit for removing the fission heat energy. The wall of the cylindrical duct is capable of withstanding the coolant-fluid pressure and of providing heat insulation between the fluid and the moderator. The insulation is smooth-surface vitreous silica capable of absorbing dimensional variations. Guidance is provided for the fuel elements by the innermost wall of the duct. (R.E.U.)

4755 IMPROVEMENTS RELATING TO NUCLEAR REACTOR INSTALLATIONS. Owen Hayden and Gilbert Harold Turner (to United Kingdom Atomic Energy Authority). British Patent 941,918. Nov. 13, 1963. Filed Apr. 11, 1961.

A nuclear reactor installation is described in which the reactor core is surrounded by a biological shield in a containment shell with ducts provided for coolant flow (liquid metal) over the shell and over the structure within the shell. An interspace is provided between the shell and a jacket so that the coolant may be brought into direct contact with the shell as a thin flowing layer for dissipating heat gained by the coolant to the outer atmosphere. This low-grade heat, which is not economically recoverable, is removed for the purpose of preservation of structures surrounding the reactor. Application is made to power-breeder reactors. (R.E.U.)

4756 NUCLEAR REACTOR. (to General Nuclear Engineering Corp.). British Patent 941,919. Nov. 13, 1963. Priority date May 31, 1960. United States.

A reactor control system which partly eliminates the use of control rods is described. Specific application is made to boiling-water reactors with either natural or natural and forced circulation of coolant. The control of the reactor is initiated by moving one core portion relative to another and particularly moving the outer region of the reactor core relative to a fixed inner region. A highly efficient boiling-water reactor is described. (R.E.U.)

4757 HETEROGENOUS NUCLEAR REACTOR. (to Aktiebolaget Atomenergi). British Patent 942,411. Nov. 20, 1963. Priority date May 11, 1960, Sweden.

A reactor in which heavy water serves as both coolant and moderator and which is self-regulating in that an increase in fuel temperature gives an almost instantaneous increase in moderator temperature with a resultant reactor power drop is described. In the reactor core, which is enclosed in a pressure vessel, fuel rods parallel to the coolant flow and in contact with all the water (at 100°C) are spaced so that the ratio of water to fuel in the core is more than 5 to 1. (D.C.W.)

4758 NUCLEAR REACTORS. (to Sulzer Freres, Societe Anonyme). British Patent 943,118. Nov. 27, 1963. Priority date Mar. 4, 1960, Switzerland.

A method and reactor that permit the fuel element changer of the reactor to be used for removal and replacement of fissile inserts in fuel elements, so that only the removed insert has to be shipped for reprocessing are described. The rod-like fuel elements consist of cans through which coolant flows and which are disposed in cavities in the moderator. The inserts can be removed from the cans through a coolant aperture. (D.C.W.)

4759 NUCLEAR REACTOR. Bernt T. A. Hargo, Dick G. Dahlgren, and Jons A. Dahlgren (to Aktiebolaget Atomenergi). Canadian Patent 669,796. Sept. 3, 1963. Priority date Mar. 20, 1959, Sweden.

A boiling reactor and a pressurized water reactor using heavy water as coolant and moderator are designed which are self-regulating, offer low resistance to the coolant flow, and have a low amount of structural material in the core. In these reactors, the fuel is in the form of linked assemblies, each of length $^1/_{10}$ to $^1/_{100}$ of the core length and separated from one another by moderator spaces. Several fuel assembly embodiments are described for each reactor. (D.L.C.)

Fuels

4760 (GEAP-4382) SODIUM COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Eighth Quarterly Report, July–September 1963. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1963. Contract AT(04-3)-189. 56p.

Progress is reported on the development of the Fast Ceramic Reactor. Information is reported on vented fuel development, fuel testing in TREAT, fuel performance evaluation, fast-flux irradiation of fuel, and reactor dynamics and design. (N.W.R.)

4761 (GEAP-4383) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Thirteenth Quarterly Progress Report, July–September 1963. C. L. Howard, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 7, 1963. Contract AT(04-3)-189. 47p.

Fuel irradiations in the VBWR have resulted in exposure increases of 1000 Mwd/t (average) for the lead assemblies of each type. The fuel continues to operate satisfactorily. Fuel assemblies 14J and 9H have small fission gas leakages, but no visible cracks or defects. Physical property tests on irradiated type 304 stainless steel, Zircaloy-4, and Zircaloy-2 fuel cladding were made. The residual stresses of non-irradiated stainless steel clad material were measured. The surface tensile hoop stress was variable from 43 to 2660 kg/cm^2 for different samples. The residual hoop stresses in stainless steel tubing were correlated to the time to failure in boiling magnesium chloride. The relative lifetimes of HPD and Fuel Cycle clad in boiling magnesium chloride do not agree with their relative lifetimes in the reactor. Stability loop data for the velocity response to a sinusoidal variation in power input are presented. The experimental and calculated results are similar in character and in frequency of the resonance response. A strong sensitivity to subcooling is shown for calculations made for the same exit quality. Tabulated data for critical heat flux in annular geometry with a rough liner is given. (N.W.R.)

4762 (GEAP-4385) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Quarterly Report No. 10, July 1–September 30, 1963. M. A. Robkin (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.).

Oct. 15, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 12p. (EURAEC-886)

The densitometry procedure (for measurement of alpha autoradiographs of fuel pellets) was modified to eliminate the need for a second emulsion. The existence of a problem of latent image fading and non-reciprocity of the high-resolution emulsion was recognized. A tentative procedure was worked out to correct these emulsion difficulties. The number of hot spots per pellet has not changed appreciably. The largest spot seen was irregular with an estimated volume equivalent to that of a sphere of 35 mil diameter with a PuO_2 concentration of 60%. Applying the same scale factor between logged exposure and Ce–Cs analysis of the first VBWR fuel sample, a corrected exposure of 4416 Mwd/t was obtained. Further debugging of EPITHERMØS, the epithermal extension of the BNL THERMØS, code, is in progress. A flux wire exposure is being prepared to map the thermal neutron spectrum in the neighborhood of the test pins in the program fuel element. (auth)

4763 (HMI-B-27) INTERPRETATION AND EVALUATION OF NON-IDEAL GAS RELEASE IN POST-ACTIVATION MEASUREMENTS (RARE-GAS DIFFUSION IN SOLIDS 11). T. Lagerwall and P. Schmeling (Hahn-Meitner-Institut für Kernforschung, Berlin). Oct. 1963. 50p.

A review is presented of possible causes of the non-ideal gas release kinetics often observed in post-activation diffusion experiments. It is pointed out, that in the calculation of diffusion coefficients from the corresponding release curves, D-values which may be different by orders of magnitude will come out, depending on different interpretation of the experimental curve. This may contribute to the uncommonly broad scattering of the values of diffusion coefficients found in the literature and shows that a deeper insight of the underlying physical processes is needed in order to evaluate the experimental data correctly. On discussing present experimental results, different assumptions regarding the nature of these processes are made, and the consequences for the experimentally observed release patterns are discussed. Recommendations are given for the evaluation of complicated release curves. (auth)

4764 (ORNL-3470(p.129-56)) GAS-COOLED REACTOR PROGRAM. A. E. Goldman (Oak Ridge National Lab., Tenn.).

Approximately 65% of the first core for the EGCR and all control rods were received. Twelve of the twenty instrumented fuel assemblies for the EGCR core were assembled. A nondestructive technique was developed to detect nonbonding of the thermocouples to the cladding of these units. Preliminary results on graphite cantilever beams under irradiation at 450°F have shown that the zero intercept and the linear creep rate vary linearly with stress. Varied fuel elements and specimens were fabricated for irradiation testing for advanced reactor concepts. Suitable procedures were developed for arc welding end closures in beryllium tubes. A Ti–6 wt % Be alloy was found to have the best wetting behavior of brazing alloys for beryllium. The effects of external pressure, cladding thickness, and friction forces on interactions between UO_2 fuel and stainless steel cladding were studied. Pyrolytic-carbon-coated uranium carbide particles were evaluated by measurement of several physical characteristics. The escape of fission-product Kr^{88} from the particles appeared to be related to the percentage of particles cracked during load tests and the coating thicknesses. Equipment capable of coating particles at up to 2000°C has been assembled. Uranium migration in coated-particle fuels heated to 1600 and 2000°C was measured by neutron activation and by low-voltage radiography. Coated particles have retained fission gases excellently ($<10^{-4}$% release at 1400°C) when care was taken not to rupture coatings. Fueled-graphite spheres and bushings were characterized. Dry chlorine gas at 800 to 1000°C markedly reduced exposed fuel, as measured by alpha counting, acid electrolysis, or neutron activation. Duplex pyrolytic-carbon coatings under irradiation have retained fission-product gases excellently. Only 1 to 2% of the coatings cracked on particles irradiated at 800 to 2100°F for up to 30 at.% burnup. Fueled graphite at 1500 to 1800°F irradiated to 2 at.% burnup retained Kr^{88} well (R/B $<10^{-7}$%). Pyroxylin films have enabled measurement of the microhardness of pyrolytic-carbon coatings. These films retain the indenter impression; the pyrolytic-carbon coating is resilient and does not. Irradiation at 650°C has produced a greater effect on strength and ductility of the British 20 Cr–25 Ni–Nb alloys than has irradiation at 750°C. Irradiation appears to have weakened or embrittled the end-closure weld region. The metal cladding of UO_2 being irradiated appears to capture all energetic recoil atoms; the gases measured on postirradiation puncturing probably result from diffusion or from boiling out from the recoil tracks that penetrate the fuel surface. The thermal conductivity of polycrystalline UO_2 was found to fit a lattice-conduction heat-transport mechanism, at least to 1100°C. Deposition of fission-product iodine and tellurium from uranium carbide at 800°C was measured. The rate-controlling step in the deposition of I^{131} on stainless steel surfaces below 300°C appears to be diffusion through the helium sweep gas. Nitrided type 304 stainless steel was found to oxidize in impure helium at 1050°F. Thus under EGCR conditions the surface properties of the nitride case would be replaced by those of an oxide film. A general interrelation was observed between strength, density, hardness, and modulus of elasticity of graphite moderator materials. The compression modulus of elasticity was much smaller than the corresponding tensile modulus for all specimens tested. (auth)

4765 (ORNL-3470(p.232-4)) WATER DESALINATION PROGRAM. D. A. Douglas (Oak Ridge National Lab., Tenn.).

Fuel fabrication costs were estimated for the very large reactors proposed for water desalination. Fabrication of 18 metric tons of uranium per day into identical elements is an insignificant part of the cost of generating heat. (auth)

4766 THE IMPACT OF GRAPHITE FUEL DEVELOPMENT ON HIGH-TEMPERATURE STEAM GENERATION. R. A. Meyer and C. L. Rickard (General Atomic Div., General Dynamics Corp., San Diego, Calif.). At. Energy Rev., 1: No. 3, 119-39(Sept. 1963).

The recent development in high-temperature graphite fuels gives promise of allowing fuel surface temperatures of approximately 1800°F, permitting the transfer of heat to make steam of 1000 to 1100°F in range, which in turn makes possible net plant efficiencies of over 40%. The thermodynamic and economic incentive for the development of this new high-temperature fuel, the potential it holds for the generation of high-temperature steam, and the associated development and testing work are discussed. The HTGR fuel element development and testing program is discussed. (auth)

4767 DIMENSIONAL INSPECTION OF RADIOACTIVE FUEL ELEMENTS. J. A. Scanlan and H. Portig (Univ. of Texas, Austin). 12p. (CONF-243-29)

From American Nuclear Society Conference on Problems

of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The measurement of fuel-element dimensions for a pulsing, pool-type reactor to meet U.S.A.E.C. requirements for close observation of the elements is discussed. A device is described for remote determination of length, diameter, and bowing of uranium–zirconium–hydride fuel elements with 0.030-inch aluminum cladding. (R.E.U.)

4768 COMBUSTION AND DISINTEGRATION OF ZIRCONIUM HYDRIDE-URANIUM FUEL RODS. F. D. Littman and A. E. Levy-Pascal (Astropower, Inc., Newport Beach, Calif.). 30p. (CONF-311-7)

From American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

Studies were made on the combustion behavior of relatively massive pieces of fuel elements, and on the behavior of small molten droplets resulting from a primary breakup of the fuel elements during re-entry. The results suggest that the probable mode of disintegration of ZrH–U fuel rods is a strong function of their re-entry trajectory, which in turn depends primarily upon the ejection altitude. (P.C.H.)

4769 IMPROVEMENTS IN FUEL ELEMENTS FOR USE IN NUCLEAR REACTORS. (to N. V. Philips' Gloeilampenfabrieken). British Patent 940,856. Nov. 6, 1963. Priority date Apr. 4, 1960, France.

A fuel element for use in nuclear reactors is described. It consists of an envelope inside which fissile material in the form of ring-shaped compact bodies, not in contact with the envelope, is provided as fuel. The fuel is surrounded by a perforated sheath of a refractory material that does not react chemically with the fuel. The thermal efficiency of the reactor may be enhanced by the smaller solid surface area of the sheath than that of the fuel. A schematic representation is given. (R.E.U.)

4770 APPARATUS FOR THE WITHDRAWAL OF SPHERICAL FUEL ELEMENTS FROM THE CORE OF A NUCLEAR REACTOR. (to Brown, Boveri & Cie, AG and Beteiligungs-und Patentverwaltungsgesellschaft mit Beschrankter Haftung). British Patent 941,108. Nov. 6, 1963. Priority date Apr. 13, 1961, Germany.

The apparatus described prevents jamming of spherical fuel elements on discharge from a reactor core. A discharge duct from the core is provided with a rotating plate which contains a hole slightly larger than the fuel elements. On rotation, the fuel elements are permitted to enter the exit hole and pass into a stationary storage area. (R.E.U.)

4771 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS AND MANUFACTURING METHOD. (to General Electric Co.). British Patent 941,806. Nov. 13, 1963. Priority date May 9, 1960, United States.

A fuel element is described in which an elongated container is provided for the fuel material with end closures integrally secured and sealed at either end of the container. At least one of the end closures contains a cavity that opens to the interior of the container and contains a resilient, porous, fluid-permeable compact. An example is given for a Zircaloy-clad fuel element of UO_2 powder with Zircaloy end plug tube bonding by hot swaging. Data are presented for effects on bonding at swaging temperatures of 1500 to 2200°F. (R.E.U.)

4772 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Frank Butler and John Frederick William Bishop (to United Kingdom Atomic Energy Authority). British Patent 942,308. Nov. 20, 1963. Filed Jan. 21, 1960.

A fuel element is described that has a member of non-fissile material disposed in it so as to space an end of the fuel member from the adjacent end of the enclosing sheath and to define a void for local end growth of the fuel member. The non-fissile material has an effective neutron absorption cross section greater than that of the fuel material in the element. (M.C.G.)

4773 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENT ASSEMBLIES. George Ralph Anthony Metcalfe and Harold Alan Brown (to United Kingdom Atomic Energy Authority). British Patent 942,323. Nov. 20, 1963. Filed Aug. 11, 1960.

A rod cluster fuel assembly in which bowing of the fuel rods under irradiation and high temperature is restrained with little restriction of coolant flow and with little additional neutron absorption is described. The fuel rods are located in alternate voids of a square lattice formed by two similar groups of parallel-disposed webs arranged edge-on to coolant flow with the webs of one group orthogonal to the webs of the other group. (D.C.W.)

4774 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Richard Arthur Shaw (to United Kingdom Atomic Energy Authority). British Patent 943,473. Dec. 4, 1963. Filed July 3, 1959.

A fuel element that avoids the usual stresses on the end cap sealing welds due to growth, swelling, and expansion is described. Two fissile material rods separated by a solid non-fissile material insert are contained in a can that initially consists of two blind-ended parts, each containing a rod. The parts of the can are joined by a circumferential butt weld over the non-fissile insert. The can is provided with longitudinal fins except around the weld. (D.C.W.)

4775 NUCLEAR REACTOR FUEL ELEMENT SHEATHING STRUCTURE. Marc Salesse, Jacques A. Stohr, and Maurice Gauthron (to Commissariat à l'Énergie Atomique). Canadian Patent 658,931. Mar. 5, 1963. Priority date May 13, 1959, France.

A method for sheathing a hollow cylindrical fuel element with an outer (finned) sheet and an inner sheet is described which ensures the intimate engagement of the inner sheet with the fuel. In the method, the inner sheet is forced against the fuel in the reactor by hot mechanical deformation using the pressurized coolant. The deformation may be facilitated by fins, folds, and corrugations in the inner sheet. (D.L.C.)

4776 NUCLEAR REACTOR FUEL ELEMENT SHEATHED WITH INFRARED PERMEABLE MATERIAL. Jean R. Perilhou and Georges le Gargasson (to N. V. Phillips' Gloeilampenfabrieken). Canadian Patent 663,150. May 14, 1963. Priority date June 3, 1959, France.

A reactor fuel element is designed which is sheathed with quartz or some other silicon compound which is pervious to infrared radiation. Thus, the consequences of separation of the fuel from the sheath are reduced, and the fuel element may be operated at higher temperatures. Several embodiments of the fuel element are described. (D.L.C.)

4777 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. Bertrand R. G. Guibert (to Commissariat à l'Énergie Atomique). Canadian Patent 672,304. Oct. 15, 1963. Priority date Nov. 18, 1959, France.

A method is described for securing fuel elements, e.g., rod assemblies, in a tubular casing. In the method, the fuel

elements are secured by means of rings bearing against the inner wall of the casing and mounted at the ends of the elements through locking or wedging means arranged so that unlocking or unwedging is impossible. (D.L.C.)

4778 NUCLEAR FUEL UNITS. Ronald Haynes (to Babcock and Wilcox Ltd.). U. S. Patent 3,111,474. Nov. 19, 1963. Priority date Aug. 30, 1956, Great Britain.

A fuel unit and fuel element sleeve are described for a solid-fuel, gas-cooled, graphite-moderated reactor whereby the elements may be safely removed with no damage to either the element or reactor. This permits any modifications to the element or reactor to be initiated. (R.E.U.)

4779 VENTED FUEL ELEMENT FOR GAS-COOLED NEUTRONIC REACTORS. W. T. Furgerson (to U. S. Atomic Energy Commission). U. S. Patent 3,114,693. Dec. 17, 1963.

A hollow, porous-walled fuel element filled with fissionable fuel and provided with an outlet port through its wall is described. In operation in a gas-cooled reactor, the element is connected, through its outlet port, to the vacuum side of a pump that causes a portion of the coolant gas flowing over the exterior surface of the element to be drawn through the porous walls thereof and out through the outlet port. This continuous purging gas flow sweeps away gaseous fission products as they are released by the fissioning fuel. (AEC)

4780 FUEL ELEMENTS FOR NUCLEAR REACTORS. Harold Montague Finniston (to U. S. Atomic Energy Commission). U. S. Patent 3,115,446. Dec. 24, 1963.

A fuel element for a nuclear reactor incorporating a body of metal of melting point lower than the temperature of operation of the reactor and a nuclear fuel in finely divided form dispersed in the body of metal as a settled slurry is presented. (AEC)

4781 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. F. G. Stengel (to U. S. Atomic Energy Commission). U. S. Patent 3,115,447. Dec. 24, 1963.

A method of fabricating nuclear reactor fuel element assemblies having a plurality of longitudinally extending flat fuel elements in spaced parallel relation to each other to form channels is presented. One side of a flat side plate is held contiguous to the ends of the elements and a welding means is passed along the other side of the plate transverse to the direction of the longitudinal extension of the elements. The setting and speed of travel of the welding means is set to cause penetration of the side plate with welds that bridge the gap in each channel between adjacent fuel elements with a weld-through bubble of predetermined size. The fabrication of a high strength, dependable fuel element is provided, and the reduction of distortion and high production costs are facilitated by this method. (AEC)

Power and Power-Breeder Reactors

4782 (AECL-1813) NUCLEAR POWER DEMONSTRATION GENERATING STATION. Final Hazards Report. (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.). Aug. 1963. 163p.

A major objective in the design of NPD-2 is the achievement of a high degree of safety. It is expected that this objective should be maintained throughout construction and operation. Sound engineering practice is applied throughout the design. Particular attention is given to: the prevention of any accidents which might result in release of radioactivity; and the reduction of the consequences of reasonably credible accidents to acceptable levels. The design is supported by extensive analytical and experimental work in critical areas. A number of conceivable accidents are studied to determine the sequence of events, the probability of occurrence, and the consequences. The situations studied include those involving loss of electrical power, loss or reduction of cooling, loss of primary coolant, loss of reactor control, and loss of primary pressure control. In all cases studied the associated risk is less than that often encountered in other industries. (auth)

4783 (AGN-TM-404) DEFECTIVE FUEL ELEMENT TESTING FOR THE ML-1. Howard S. Dreyer (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 1963. Contract AT(10-1)-880. 61p.

Calculations and experiments were performed to measure the steady-state release of fission gas from sheathed fuel pins with one or more pin-hole defects. Calculated values were compared with results of in-pile tests of three intentionally defected ML-1 fuel pins. The tests verified predictions that fission gas release and plate-out of fission products would not result in significant problems in the ML-1. Oxidation of fuel was not severe after one month of power operation using air as a coolant. It was concluded that the calculational method described provides an adequate prediction of fission gas release in clad fuels. Experimental procedures and apparatus used for in-pile testing were found to be effective and relatively inexpensive. (auth)

4784 (ANL-6622) DEVELOPMENT AND MANUFACTURE OF FUEL, BLANKET, AND THERMOCOUPLE RODS FOR THE EXPERIMENTAL BREEDER REACTOR I, CORE IV. W. R. Burt, Jr., A. G. Hins, R. M. Mayfield, and A. B. Shuck (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 67p.

A description is given of the development and manufacture of Core IV for the Experimental Breeder Reactor I (EBR-I). A total of 420 rods and 10 thermocouple fuel rods containing plutonium-1.25 wt % aluminum fuel slugs were made. In addition, 120 blanket rods and 5 thermocouple rods were assembled with depleted uranium slugs. Both the fissile and fertile slugs were NaK bonded in Zircaloy-2 jacket tubes. The fuel alloy was made by induction melting plutonium and aluminum. The centrifugal casting technique developed for EBR-I, Core-II was tried without success with this alloy. The gas pressure injection casting method developed for the EBR-II fuel cycle was used to cast the Core-IV rods. These were parted into rough slugs which were roll-sized and coined to final shape. After coining, the slugs were heat-treated and inspected. A loading technique was developed to protect the outside of the jacket tube and the weld zone from plutonium contamination. A connector fitting, with an integral tube for NaK filling, was welded to the top of the jacket tube. A measured quantity of NaK was injected through the fill opening by a hypodermic needle and syringe. The filling tube was then welded closed by the capacitor-discharge technique. The rods were then heat treated, leak detected, eddy-current bond inspected, x-rayed for NaK level, and gaged. All rods were surveyed for alpha contamination of the external surfaces and were shipped in approved birdcages to the reactor site. (auth)

4785 (ANL-6659) BREEDING-GAIN SPECIMENS FOR EBR-I CORE IV. A. B. Shuck, A. G. Hins, W. R. Burt, and R. A. Beatty (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 35p.

The design and fabrication of Al-clad Pu foils and slugs, enriched and depleted U foils, and depleted U blanket slugs for breeding-gain studies with the plutonium core IV are described. The construction and dimensions of the irradiation baskets and thimbles are shown, and the special core fuel, blanket, and thermocouple rods are described. (D.C.W.)

4786 (BAW-1273) SPECTRAL SHIFT CONTROL REACTOR BASIC PHYSICS PROGRAM. MEASUREMENT AND ANALYSIS OF UNIFORM LATTICES OF SLIGHTLY ENRICHED UO_2 MODERATED BY D_2O-H_2O MIXTURES. T. C. Engelder, R. H. Clark, M. N. Baldwin, E. J. DeRoche, G. T. Fairburn, J. W. Hallam, D. H. Roy, N. Vutz, and T. M. Schuler (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Nov. 1963. Contract AT(30-1)-2602. 150p.

Experimental results and theoretical interpretation of a series of twenty uniform lattice critical experiments in which the neutron spectrum is varied over a fairly broad range are summarized. Two types of fuel rods were studied: 4.02%-enriched UO_2 in stainless steel tubes; and 2.46%-enriched UO_2 in aluminum tubes. Lattice nonmoderator-to-moderator volume ratios ranged from 0.65 to 1.2. The moderators were mixtures of light and heavy water ranging in composition from zero to 77% D_2O, with and without boric acid. Measurements include critical size and composition, $\partial\rho/\partial h$, buckling and reflector savings, thermal disadvantage factor, and cadmium ratios of U^{235} and U^{238}. Theoretical methods used to analyze the data are given, and results are compared. (auth)

4787 (BAW-1283) SPECTRAL SHIFT CONTROL REACTOR BASIC PHYSICS PROGRAM. MEASUREMENT OF k_∞ AND OTHER LATTICE PARAMETERS BY THE SMALL LATTICE EXPERIMENT TECHNIQUE. T. C. Engelder, N. L. Snidow, D. M. Roberts, G. T. Fairburn (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.); and D. H. Roy (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Nov. 1963. Contract AT(30-1)-2602. 124p.

The Small Lattice Experiment (SLE) is a technique for measuring k_∞ and other infinite-medium lattice parameters using much less test fuel than is required for equivalent critical or exponential experiments. The theoretical basis for applying such an experiment to epithermal lattices is discussed, an analysis of spectral mismatch error is given, and the facility for the measurements is described. SLE measurements are compared to those in an equivalent critical assembly to test the validity of the technique. In an epithermal lattice of 4.02%-enriched UO_2 fuel rods having a nonmoderator-to-moderator volume ratio of 1.0 and moderated by a D_2O-H_2O mixture containing 70% D_2O, values of k_∞, $\bar{\phi}_m/\bar{\phi}_f$, δ_{25}, and ρ_{28} agree within statistical errors (0.5 to 1%). The SLE technique was also used to measure these parameters in two similar epithermal lattices containing ($U^{235}-ThO_2$) fuel rods ($N_{Th}/N_{25} = 15$). (auth)

4788 (BNL-6834) ADVANCED COMMERCIAL POWER REACTORS. Chad J. Raseman and Leon Green (Brookhaven National Lab., Upton, N. Y.). Feb. 28, 1963. Contract AT(30-2)-Gen-16. 132p.

A review is presented of developmental progress in commercial power reactors. The reactor types studied include: sodium-graphite reactors; fast reactors; heavy-water-moderated reactors; and organic cooled and/or moderated reactors. (T.F.H.)

4789 (CONF-243-25) ML-1 POWER DETERMINATION. R. E. Lightle (Aerojet-General Nucleonics, San Ramon, Calif. and Phillips Petroleum Co., Idaho Falls, Idaho). [nd]. Contract [AT(10-1)-880]. 13p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The Army ML-1 reactor is described, and the thermodynamic calculation used for determining its power level is outlined. The parameters in this calculation include the coolant-gas temperature rise in the core, flow-rate, and specific heat, and the heat loss to the moderator. The calculation has an accuracy of 10%. (T.F.H.)

4790 (CONF-334-4) RECENT IMPROVEMENTS IN CALCULATIONS OF DOPPLER AND SODIUM REACTIVITY EFFECTS FOR LARGE FAST REACTORS. P. Greebler (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). [1963]. Contract AT(04-3)-189. 15p.

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

Reactivity effects of sodium losses in large fast reactors are studied. The influence of these losses on the Doppler coefficient is considered. The effects of fuel and coolant heterogeneity, crystalline binding in the fuel, s-wave resonances, and choice of computational formalism upon the Doppler coefficient are analyzed. (T.F.H.)

4791 (CVNA-143) COST AND ASSISTANCE REPORT AS OF APRIL 30, 1962. (Carolinas Virginia Nuclear Power Associates, Inc., Columbia, S. C.). Apr. 30, 1962. Contract AT(30-1)-2289. 9p.

Costs incurred for research, development, and construction in the Power Reactor Demonstration Program of the Carolinas-Virginia Nuclear Power Associates are tabulated. (T.F.H.)

4792 (DLCS-5001063) MONTHLY OPERATING REPORT [ON PWR OPERATIONS], OCTOBER 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT-(11-1)-292. 55p.

Operations during October were performed in accordance with the requirements of operational testing, which limited continuous steady state operations at full power. During the month the Station was shut down for a two-day period for low power physics testing. Other conditions restricting full power operations were periods of reduced electrical output regulated by the requirements of the "Observation of Core Coupling" test and special FEDAL testing. Reference water conditions were maintained in the RCS and in the Reactor Plant auxiliary systems throughout October. The Canal Water System was out of specifications for a short period; however, reference conditions were re-established and maintained during the remainder of the month. The boiler water in all operating boilers was also maintained within specifications during October. During weekly routine sampling, a small quantity of metallic mercury was located on the after ion exchanger crud probe. A sampling program was established to determine the extent of the mercury in the Purification System. A biocide treatment was initiated for the control of biological fouling in the RWDS. Results of routine radiological surveys performed during October revealed no unusual occurrences of contamination in the Station. All personnel radiation exposures were within specified limits. Fifteen tests were performed in October, four of which were still in progress at the end of this report

period. During the month, 15 test procedures, three test evaluations and five preliminary reports for Core 1, and five test procedures for Core 2 were issued. One union and three non-union personnel continued on-the-job training for Reactor Operator and Shift Reactor Engineer positions, respectively. Construction of the Decontamination System was still in progress at the end of the month. A contract for the mechanical portion of the HDS major modification work was awarded in October with work scheduled to begin in November. (auth)

4793 (GA-4693) BERYLLIUM OXIDE AS A MODERATOR FOR HIGH-TEMPERATURE, GAS-COOLED REACTORS. A. D. McWirter and A. J. Goodjohn (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Nov. 10, 1963. Contract AT(04-3)-187. 15p. (CONF-187-16)

From American Nuclear Society Meeting, New York, Nov. 1963.

Also included in TID-7682.

Some of the features of BeO-moderated reactors attainable in the near future are indicated. If BeO can be used as a moderator without relying on its mechanical strength, it appears that BeO-moderated gas-cooled reactors are feasible that are capable of power production in the range of 50 to 500 electrical megawatts. A BeO reactor with a conversion ratio of unity, a self-sustaining system, is possible in the larger-size power plants at a modest increase in fuel-cycle cost. Much of the validity of this study is based on assumed cost data, particularly the fuel-compact fabrication costs where there are no guiding precedents. (auth)

4794 (GAMD-4273) LIFETIME CHARACTERISTICS OF A PEACH BOTTOM SIZE HTGR—DEPENDENCE UPON THE DIMENSIONALITY OF THE CALCULATION AND UPON THE NUMBER OF NEUTRON ENERGY GROUPS. K. R. Van Howe (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 24, 1963. Contract AT(04-3)-314. 20p.

The lifetime characteristics of typical Peach Bottom size (40 Mw(e)) HTGR as obtained with various computational models are compared. The burnup history is calculated with consistent two-dimensional, one-dimensional, and zero-dimensional depletion codes using three slowing down and one thermalization neutron energy groups. The effect of multiple fast and multiple thermal energy groups is investigated with the zero-dimensional depletion model. (N.W.R.)

4795 (GEAP-3924) NUCLEAR SUPERHEAT PROJECT ELEVENTH QUARTERLY REPORT, JANUARY–MARCH 1962. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Aug. 1962. Contract AT(04-3)-189. 302p.

Results of a study concerning the optimum type or types of superheat elements are presented. A seven-rod fuel element appears to be the most promising design for nuclear superheaters. It is recommended that the combination-type element with internal coolant channels be investigated. Physics work during the period was devoted to the core for a 600-Mw(e) reactor. Results of analysis of flooding effects on reactivity are presented along with data on effects of moderator temperature and control rod worth. Examination of fuel element SH-5A after irradiation at 750 to 845°F for 1000 hr revealed small cracks in the cladding of intergranular nature. A description of the NUSU irradiation operation is included. Data are included on the ESH-1 and ESH-2 fuel design. Data are included which show that the stainless steel tubing rejection rate is about 10%. Development of welding parameters for 10- and 20-mil-thick Inconel, Hastelloy X, Hastelloy N, Ni-o-Nel, and stainless steel is reported. It was found that end plugs involving these alloys can be welded without undue preparation. Test work done on type 304 stainless steel stress corrosion is summarized along with results of a 1000-hr check on stress corrosion of Inconel and Incoloy. Results are also included on the effects of 1100°F steam on Hastelloy N and Inconel, and on the SH-5A and NuSu tests. In mechanical development efforts during the period were devoted to procurement of a plastic shroud for air-water testing and to a series of steam-water tests. A design and irradiation summary for SADE fuel elements is given. Work on the E-SADE is about 70% complete. Information is included on design of the 75-Mw(e) Mixed Spectrum plant along with data and information on the Mixed Spectrum Superheater Critical Experiment. (J.R.D.)

4796 (GEAP-4153) NUCLEAR SUPERHEAT PROJECT FOURTEENTH QUARTERLY REPORT, OCTOBER–DECEMBER 1962. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 15, 1963. Contract AT(04-3)-189. 286p.

The problem of steam flow control in large separate superheat reactors was investigated. Findings concerning steady-state pressure drop at full load are presented along with those concerning fuel bundle orificing requirements under normal operating conditions, and use of converging-diverging nozzles in the exit steam piping to limit differential across the process tube under the accident conditions of external steam pipe rupture. Results of post-irradiation ESH-1 fuel element examination are included along with results of 310 and 304 stainless steel tensile tests. No changes in Hastelloy X grain structure were noted after 1000 to 2000 hours of superheat environmental testing. Data on clad material corrosion by boiling $MgCl_2$ are summarized. Thermal cycling test results for coolant systems stainless steels are presented, and data on heat transfer with superheated steam are included. Results of efforts to learn more about the velocity and pressure distribution in the flow on the vessel wall simulator of the full circle radial vane separator are reported. Other data are given on design of the ESH-1 and -2 fuel elements. The conceptual design of the mixed Spectrum Superheater Critical Experiment is described. (J.R.D.)

4797 (GEAP-4203) METHODS FOR IMPROVING THE CRITICAL HEAT FLUX FOR BWR'S. C. L. Howard (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 1963. Contract AT(04-3)-189. 76p.

Proposals for increasing the critical heat flux in BWR's are screened, viz. film trippers on unheated channel walls, spacer-orifices, thick and massive fins, thin and small fins, twisted ribbons, downward flow, electrical fields, and addition of additives to the coolant. Several of these concepts are chosen for developmental study. (T.F.H.)

4798 (GEAP-4327) HIGH POWER DENSITY DEVELOPMENT PROJECT. POTTER METER CALIBRATION AND INSTRUMENTED FUEL BUNDLE PRESSURE DROP. E. E. Polomik and C. L. Swan (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 26, 1963. Contract AT(04-3)-361. 82p.

Eight meters for metering inlet flow and measuring exit steam qualities in the Consumers Big Rock Point instrumented fuel assemblies were individually calibrated for flow and pressure drop up to 500 gpm in a low-temperature (130°F) fluid-flow facility. The flow calibration comparison agreed within 1% among seven of the meters. One meter

was 2.8% lower than the others. Pressure drop among meters was within about 5%. Locked-rotor pressure drop data were obtained on one meter. A fully instrumented fuel bundle was tested in the low-temperature facility. Pressure-drop data were obtained for the tieplates and meters, spacers, and channel rods. A mock-up of the exit end of the instrumented fuel bundles, composed of 1 foot of fuel rods, tieplate, and meter was tested in a high-pressure heat-transfer facility. Data were obtained for single- and two-phase calibration of the meters, and for pressure drop. Equations were developed for calculation of total flow and exit steam quality in an instrumented bundle. (auth)

4799 (LADC-5825) AN APPLICATION OF MOLTEN PLUTONIUM FUEL TO FAST BREEDERS. W. H. Hannum, G. L. Ragan, and B. M. Carmichael (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 19p. (CONF-334-1)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

Successful power operation of LAMPRE I supports the promise of molten Pu as a fast reactor fuel. No significant operational difficulties are experienced. A Ta thermal limitation and the Ta parasitic absorption are determining factors in the compromise between specific power and breeding ratio. With conservative assumptions, favorable doubling times are predicted. If long driver-fuel-element lifetime is feasible as anticipated, favorable fuel cycle costs should be available. A strong negative temperature coefficient owing to fuel expansion is anticipated. While the reactor considered in this discussion is based on a straightforward extension of the LAMPRE I facility, there are several features that are extrapolations from proven technology. For instance, Pu–Co–Ce is the fuel alloy assumed. The properties, including gas retention, of this alloy after high irradiation, are not yet established. Furthermore, Ta integrity after long irradiation is not yet established. (auth)

4800 (NAA-SR-8722) PIQUA NUCLEAR POWER FACILITY OPERATIONS ANALYSIS PROGRAM. Progress Report No. 2, Fiscal Year 1963. J. J. Auleta, D. B. Finch, L. Goodman, D. E. Lew, H. Mandel, and H. J. Rubinstein (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 30, 1963. Contract AT-11-1-GEN-8. 176p.

The design, development, operation, and testing of the Piqua Power Facility are described. Progress is reported in these areas: reactor analysis and shielding; coolant chemistry and analysis; systems and components analysis; fuels and materials analysis; and technical specifications and operating limits. (N.W.R.)

4801 (NYO-9992) EURATOM REACTOR FUEL MANAGEMENT PROGRAM. PART III. FUEL CYCLE ANALYSIS. (Jackson and Moreland, Inc., Boston and Allis-Chalmers Mfg. Co., Milwaukee). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2875. (EURAEC-803(Pt.III)). 108p.

A nuclear fuel-cycle parametric study is made with the objective of economic optimization of overall unit power costs for the reference-design (Senn) reactor. The assumptions and ground rules used in this study are outlined. Charges incurred before, during, and after irradiation are considered, and fuel cycle unit energy costs are calculated. Recommendations are made for future work in fuel cycle cost analysis. (D.L.C.)

4802 (TID-7683(p.36)) SCALE, NUCLEAR ECONOMICS, AND SALT WATER. Alvin M. Weinberg (Oak Ridge National Lab., Tenn.).

R. P. Hammond's studies of scaling of power reactors show that scaling carried far enough could reduce the cost of nuclear energy much below the cost of conventional energy. The cost of D_2O-moderated reactors is estimated to vary as $P^{0.8}$. The price of Pu in large power reactors is considered. It is suggested that the exhaust steam from such reactors be used in desalination plants. If such large reactors are developed as anticipated, large breeders will be needed, and it is believed that the fast breeder will scale favorably. The AEC strategy of civilian nuclear energy development is discussed. Finally, the mismatch between the scale of economic nuclear power and that of social organization is commented upon. (D.L.C.)

4803 (WCAP-6057) STATISTICAL ANALYSIS OF ALPHA-25 OBTAINED FROM DESTRUCTIVE ANALYSIS OF SPENT YANKEE FUEL. J. Jedruch (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Nov. 1963. Contract AT(30-1)-3017. 28p.

The value of the capture to fission ratio for U^{235}, α^{25}, in the spent Yankee fuel was computed from the results of mass spectrometric analysis of ten fuel samples taken from two fuel rods. Methods of statistical analysis were then applied to the results to give for the fuel at the center of the fuel assembly $\alpha^{25} = 0.231 \pm 0.008$ and for the fuel at the corner of an assembly, next to a water slot and a Zircaloy control rod follower, $\alpha^{25} = 0.210 \pm 0.005$, where the errors are standard deviations of the mean. Dispersion of data was found to be comparable to that reported for α^{25} in BNL-325. (auth)

4804 (AEC-tr-6155) FORMULARY FOR THE CALCULATION OF THE SHIELD OF POWER REACTORS. (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated from report DEP/SEPP/211/62. Mar. 1962. 82p.

Formulas and systematics are presented that permit simple calculations of the different neutron and gamma fluxes in power reactors, and the establishment of minimum quantities of materials to be utilized so that general safety conditions for both personnel and installation will ensue. The techniques presented are designed for use following the choice of general concept for the power plant. (T.F.H.)

4805 CONTAMINATION OF THE STEAM OF BOILING REACTORS BY THE DISSOLUTION OF THE IMPURITIES OF THE WATER IN THE STEAM. M. A. Styrikovich and O. I. Martynova. At. Energ. (USSR), 15: 214-18(Sept. 1963). (In Russian)

Up to now, deposition of radioactive materials from the vapor phase did not cause any serious contamination of single-loop atomic power stations. However, use of superheated steam in such systems presents a definite hazard because the wet steam does not wash off the deposited solids and the solubility of the various impurities in the vapor phase is greatly increased. In view of the usual high purity of the feed water, the impurities found in it usually consist of the corrosion products of the structural metals, specifically, the oxides of Fe, Cr, Co, Cu, Mn, and Zn and depending on the cladding used, of Zr or Al, together with the fission products which might have leaked out of the fuel elements. The contamination becomes quite marked at pressures exceeding 140 atm. The transfer coefficients from the aqueous to the vapor phase are difficult to calculate because they may vary for various compounds of the same

element; they depend primarily on the high-temperature solubility of the compound and on the pressure. Studies carried out at the Moscow Energy Institute indicated that an increase in the vapor pressure results in an increase of the transfer from the aqueous to the vapor phase. For some weak electrolytes, pressures of about 60 atm exert a positive effect. The steam is contaminated only by the truly steam-soluble portion of the total dissolved material in the water phase. Further studies are needed before it is possible to specify the purity of feed water of boiling reactors. (TTT)

4806 ANALYSIS OF DESIGN CRITERIA FOR BOILING WATER REACTORS. L. Sani (Direzione Costruzioni Centrali Termiche e Nucleari, Rome). At. Energy Rev., 1: No. 3, 47-118(Sept. 1963).

The preliminary study of the plant thermodynamics is followed by an analysis of the parameters affecting the thermal design of the core. Particular attention is paid to the core thermal-hydraulic design, in view of the attainment of fairly high power density values without compromising the core safety and/or the system stability. The core nuclear design is considered with the aim of achieving two major objectives: economic optimization and nuclear safety. (auth)

4807 THE EFFECT OF INTEREST RATES, TAXES, AND AMORTIZATION TIME ON THE CURRENT GENERATION COSTS IN NUCLEAR POWER PLANTS. Klaus-Dieter Fischer (Universität, Cologne). At. Strom, 9: 69-72 (Sept. 1963). (In German)

An attempt is made to evaluate the effect that useful life, interest rates, and taxes have on the power generation costs in a nuclear power plant. Comparisons were made among gas-cooled natural uranium reactors, boiling water reactors, and coal power plants. The results of the evaluation of these three factors are shown graphically and in tabular form. (J.S.R.)

4808 SAFETY ENCLOSURE OF POWER REACTORS. [PARTS I AND II]. Thomas Jaeger. Atomkernenergie, 5: 15-18; 100-7(1960). (JUL-96-RG). (In German)

The design of the gas-tight safety enclosure for a nuclear power plant depends on the estimate of the energy release during the worst credible accident postulated for the primary system. The potential sources of energy include nuclear excursions, chemical reactions of liquid-metal coolants with air, release of stored thermal energy from pressurized systems, and chemical reactions between reactor core materials and water. Some of the factors to be evaluated in designing a containment shell are: vessel size and shape, static and dynamic loading, construction materials, supporting structure, protection of the shell from damage by effects of explosive energy releases, tightness requirements, and leakage testing procedures. In the majority of cases the vertical cylindrical steel shell is used as containment vessel for small (prototype-) plants and the spherical steel shell for large power plants. Representative examples are the cylindrical container enclosing the EBWR-plant and the spherical container enclosing the primary system of the Dresden nuclear power plant. Alternatively, reactor systems can be enclosed in chambers located in rock. (auth)

4809 PRESENT AND FUTURE DEVELOPMENT OF NUCLEAR ENERGY IN THE U.S.A. Brennstoff-Waerme-Kraft, 15: 537-9(Nov. 1963). (In German)

The role of nuclear energy in the American economy is discussed. Yearly and cumulative energy requirements for the years 1960 to 2300 are shown and compared with the supply of conventional fuel. The energy content of the supply of fissionable and breeder materials available in the USA is shown in tabular form. The role of the AEC is discussed. (M.C.G.)

4810 THE DEVELOPMENT IN FRANCE OF THE REACTOR SYSTEM NATURAL URANIUM–GRAPHITE–CO_2. EXPERIENCE ACQUIRED. FUTURE PROSPECTS. J. Horowitz and J. P. Roux. Bull. Inform. Sci. Tech. (Paris), No. 76, 3-11(Oct. 1963). (In French)

The uranium–graphite–CO_2 reactors constitute the basis of the French electro-nuclear power station program. The reactors EDF 1, EDF 2, and EDF 3 at Chinon follow up the plutonium piles G 2 and G 3 at Marcoule, and these together represent the major part of the 850 Mw of electricity which was planned for 1965 by the third equipment program. G 2 and G 3 have been supplying electricity to the French national grid since 1959 and 1960 respectively. EDF 1 underwent 1963 preliminary tests in early 1963 prior to power operation; it is planned that EDF 2 will come into service at the end of 1964 and EDF 3 during 1965. A review of the development of this reactor system in the light of experience acquired on this type of reactor is presented. The progress achieved in the laboratories on the various technical aspects, neutronic, thermal, mechanical, and metallurgical, and the development prospects resulting from them are discussed. The experience acquired from the construction of the various reactors and the technical and economical conclusions resulting from it are described. The operational experience of the Marcoule reactors and of the first trials of the EDF 1 reactor, are reviewed. An attempt was made to define the prospects of this type of reactor in the French program, by distinguishing between the technical practicability and the economic feasibility. (auth)

4811 THE FRENCH FUEL ELEMENTS FOR THE SYSTEM NATURAL URANIUM–GRAPHITE–CARBON DIOXIDE. R. Boussard and G. Jeanpierre. Bull. Inform. Sci. Tech. (Paris), No. 76, 13-26(Oct. 1963). (In French)

Results of studies carried out in France on fuel elements used in reactors of the type natural U–CO_2–graphite are presented. The desire to increase the specific power extracted through the channels of this type of reactor led to research into the nature of the fuel itself and of the canning material, as well as into the geometry of the fuel element. Each stage in the building program of the EDF power stations of this type (EDF 1, EDF 2, EDF 3, at the Chinon Center) was marked by the study of a different fuel element. The industrial policy of the C.E.A. for large-scale production is described. The termination of the studies is marked by in-pile resistance tests, which are carried out both in experimental reactors of the EL 3 type at Saclay and in operational power reactors of the G 2/G 3 type at Marcoule. (auth)

4812 PRESTRESSED CONCRETE VESSELS IN THE FRENCH POWER REACTOR PROGRAM. C. Dambrine, D. Caussot, and F. Conte. Bull. Inform. Sci. Tech. (Paris), No. 76, 27-45(Oct. 1963). (In French)

The application of prestressed concrete to the reactors G 2 and G 3 at Marcoule and to the reactor EDF 3 under construction at Chinon is discussed. The construction of the reactor vessels for G 2 and G 3 began in 1956; the reactors have been operating under power since 1959 and 1960 respectively. The problems that arose during the construction of the reactor vessel, and the philosophy of the observations made during operation, which tend to show the safety of this equipment are discussed. The construc-

tion of the vessel for EDF 3 was begun at Chinon in the second half of 1961. The reasons for the choice of this vessel, the results of the calculations and trials carried out on a model, and the problems posed by the construction are listed. Various studies were carried out on the possibilities of units made of prestressed concrete for reactors. It appears that it is possible, if so desired, to increase the operating pressure and also to increase notably the size, thus making it possible to consider solutions of the integrated type. (auth)

4813 ORIENTATION STUDY OF A GRAPHITE REACTOR WITH ANNULAR FUEL ELEMENTS. P. Bacher and L. Guccia. Bull. Inform. Sci. Tech. (Paris), No. 76, 57-72(Oct. 1963). (In French)

With the EDF 3 type fuel element, made up of a uranium tube cooled externally only, it is not possible to take full advantage of the possibilities offered by the "integrated" system, i.e. a graphite reactor having all the primary circuits inside a prestressed concrete vessel. The use of an "annular" fuel element, however, made up of a uranium tube cooled both externally and internally makes it possible to increase the CO_2 cooling gas pressure and to increase considerably the performance, in particular the specific power. The methods used for defining a 500 Mw(e) reactor equipped with annular elements are outlined. Compared to EDF 3 the power per unit volume is increased from 1.1 Mw(t)/m^3 to 2 Mw(t)/m^3, the specific electric power from 1.1 Mw(e)/t to 1.9 Mw(e)/t, and the number of channels decreases from 2,700 to 850. (auth)

4814 SOME ECONOMIC ASPECTS OF THE NATURAL URANIUM–GRAPHITE–GAS REACTOR SYSTEM. J. Gaussens. Bull. Inform. Sci. Tech. (Paris), No. 76, 73-86(Oct. 1963). (In French)

After showing that certain reactor systems, in particular the natural uranium–graphite system, have reached a development stage that makes them economically interesting, the advantages of natural uranium in this type of reactor are listed as low cost and simplicity of the fuel cycles, reduction of the economic uncertainties and of the financial capitalization inherent in this fuel, and ease of procuring natural uranium and its low storage costs. The medium term aspects and the present trends of the price of the kwh of nuclear power stations of this type and the amount of capital charges involved are reviewed. (auth)

4815 CONTROL OF THE REACTOR AT THE HINKLEY POINT NUCLEAR POWER PLANT. R. B. Quarmby and H. Law. CENUSA (Bol. Centrales Nucl., Soc. Anon.), No. 39, 4-27(Jan.-Feb.-Mar. 1963). (In Spanish)

A brief review is given of the systems used for the control of the reactivity, temperature, rod movement, and power levels. The factors considered in the design of the control systems are briefly indicated. (J.S.R.)

4816 THE ECONOMY OF CLOSED-CYCLE WATER REACTORS. A. R. Jones (Westinghouse Electric Corp., Pittsburgh). CENUSA (Bol. Centrales Nucl., Soc. Anon.), No. 39, 28-35(Jan.-Feb.-Mar. 1963). (In Spanish)

The principal reduction in the capital costs of pressurized water reactors in the last few years has resulted from the development of large components of the cooling circuits and the adoption of a modular design. The possibilities in the reduction of fuel costs in the future are indicated. The generation costs are evaluated as a function of the power level, annual charge, and utilization factors. Future generation costs are estimated. (J.S.R.)

4817 SECURITY AND CONTROL TESTS OF THE FIRST BELGIAN NUCLEAR POWER PLANT BR3. Maurice Gueben. Energie Nucl., 5: 412-26(Sept.-Oct. 1963). (In French)

A description is given of the nuclear power plant BR3, and of the analysis of all tests done before and after starting. The measuring methods, their difficulties and advantages, and results are emphasized. Although security and nuclear control tests are given particular attention, others are not ignored. The problem concerning operator formation is also dealt with. (auth)

4818 METALLIC FUEL ELEMENTS FOR GAS-GRAPHITE REACTORS IN ITALY. Carlo Fizzotti. Indian Eastern Engr., 167-9(1963).

An investigation was made of the thermal stability, structure, and phase changes of specimens of adjusted uranium, and U–Mo, U–Zr, and U–Nb alloys subjected to different thermal treatments and irradiation tests. (Rev. Metal Lit., 20: No. 11, Nov. 1963.)

4819 AN EVALUATION OF THERMAL BREEDING. Paul R. Kasten (Kernforschungsanlage Julich des Landes Nordrhein-Westfalen e.V., Ger.). Nukleonik, 5: 299-310 (Oct. 1963).

Thermal breeding is discussed with emphasis on the interplay of variables that need to be considered in breeder reactor evaluation. Reactor performance is described as a function of reactor type, fuel material, and economic conditions. The basis on which breeder reactor development should proceed is considered. The basic physics constants associated with various reactor fuels, the relationship between fuel cycle cost and breeding ratio as a function of technological and economic conditions, and the influence of moderator, fission products, and fuel isotopes on breeding ratio are discussed. (M.C.G.)

4820 THE THERMO-AERODYNAMICAL ANALYSIS OF GAS FLOW IN POWER REACTOR. Itaru Michiyoshi. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 10: No. 6, 75-88 (Aug. 1960).

The differential equations for calculation of temperature, velocity, and pressure distributions through a channel are proposed. These equations may be solved easily not only by Runge-Kutta's numerical calculation as is done for one example but also by computer. (auth)

4821 OPERATIONAL EVALUATION OF THE AIR FORCE'S PM-1 NUCLEAR POWER PLANT. John W. Baker, James R. Bohannon, Jr., Robert M. Ehrlich, and James T. Westermeier. 33p. (CONF-243-32)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The basic objectives, field testing, and other operational aspects of the Air Force program for portable medium power generation are discussed. (R.E.U.)

4822 PERFORMANCE AND RELIABILITY OF NPD. L. W. Woodhead (Hydro-Electric Power Commission of Ontario). 31p. (CONF-243-26)

American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Specifications and operating procedures of Nuclear Power Demonstration are presented. The history and future expectations of the electric power station are discussed. (R.E.U.)

4823 SOME NUCLEAR CHARACTERISTICS OF NPD. C. E. Till and A. C. Whittier (Canadian General Electric Co. Ltd., Peterborough, Ont.). 24p. (CONF-243-28)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The first approach to criticality was carried out by raising the moderator level and plotting $1/\phi$ vs a calculated k_{eff}. The moderator level was calibrated for use in reactivity measurements. The moderator temperature effect and coolant temperature effect on reactivity were less than expected. The power coefficient, booster rod worth, and H_2O reflector worth agree with calculation. The effect of fuel burnup on reactivity is less than expected. (auth)

4824 OPERATING EXPERIENCE WITH RUPTURED FUEL IN THE VALLECITOS BOILING WATER REACTOR. E. L. Burley, J. C. Major, H. D. Ongman, C. M. Richards, E. J. Strain, and J. B. Violette (General Electric, San Jose, Calif.). 40p. (CONF-243-27)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The failed-fuel test program in the VBWR and the first in-service fuel failure are discussed. The effects of operating with ruptured fuel, the detection of the failed fuel, and plant maintenance are discussed. (R.E.U.)

4825 CUTTING AND REMOVAL OF A DAMAGED CONTROL ROD BASKET AT THE SM-1 NUCLEAR POWER PLANT. Garrett V. Sidler, John C. Bouldin, and Charles R. Feavyear (Army Engineer Reactors Group, Fort Belvoir, Va.). 12p. (CONF-243-12)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

During the spiking and rearrangement of Core I is SM-1, four control rod end caps and two control rod baskets were damaged because of improper removal procedures. The methods for removal of the end caps and replacement of baskets are outlined. The cutting procedure and holding fixture are applicable to a variety of underwater uses. (R.E.U.)

4826 A STEAM SUPERHEATING NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH). British Patent 941,132. Nov. 6, 1963. Priority date Feb. 26, 1959, Germany.

A reactor is described in which the core is used for superheating the steam from a reactor supplier. The pressure vessel is partially filled with water and has a steam inlet above the water level. The reactor core consists of parallel tubes with fuel elements arranged within. The wet steam is passed among the outer fuel elements and then among the inner fuel elements where the superheating takes place. Pressures of 70 atm and temperatures of 500°C can be obtained. (R.E.U.)

4827 NUCLEAR REACTOR TURBINE OPERATED WITH URANIUM HEXAFLUORIDE AS REACTOR CORE FUEL. Hermann Clasen (to Metallgesellschaft AG). Canadian Patent 670,534. Sept. 17, 1963. Priority date Nov. 8, 1957, Germany.

A nuclear reactor using UF_6 as fuel and working medium is described in which the core also constitutes the driving part of a turbine aggregate. The energy of the chain reaction acts directly on the turbine blades, and the escaping UF_6 vapor is fed to the compression stages and then reintroduced into the core. The turbine parts exposed to UF_6 are made of Be, Ni, Al, Cu, or Ni–Cu–Mn–Fe alloy or are coated with a refractory. An electromagnetic clutch is connected to the turbine rotor. (D.L.C.)

Process Heat Reactors

4828 (ORNL-TM-735) REGIONAL WATER SUPPLY BY NUCLEAR DESALINATION. R. Philip Hammond (Oak Ridge National Lab., Tenn.). Nov. 26, 1963. Contract [W-7405-eng-26]. 19p. (CONF-187-23)

From American Nuclear Society Meeting, New York, Nov. 1963.

Comparison of nuclear desalting plants with conventional water supply projects now proposed for the southwestern United States shows that the nuclear stations are at least competitive in some areas, and this competitive position will improve as water needs increase and nuclear costs come down. An independent study made for the Office of Science and Technology confirmed the Oak Ridge National Laboratory's estimates of low energy costs from very large reactors. (auth)

4829 NUCLEAR REACTOR FOR THERMAL PROCESSING OF MATERIAL. Rudolf Schulten (to Brown, Boveri & Cie AG). Canadian Patent 664,366. June 4, 1963. Priority date Mar. 24, 1959, Germany.

A reactor for the heat processing of materials is designed which has no cooling system but instead has the materials located directly in the core. Two groups of channels are provided, one for the fuel elements and one for the materials to be treated. The reaction may be shut down for the duration of the processing treatment, in order to minimize radioactive contamination. The use of the reactor is described with reference to the production of calcium carbide and phosphorus. (D.L.C.)

Production Reactors

4830 (HW-SA-3095) HANFORD REACTOR OPERATING PERSONNEL CERTIFICATION. Sterling L. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 20, 1963. Contract AT(45-1)-1350. 12p. (CONF-243-19)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A description is given of the development and application of the certification training and testing program for the operating personnel of the plutonium production reactors in the Irradiation Processing Department. The problems encountered and the setting up of a pilot group are described. The classroom techniques and certification tests are discussed. The results and future programs are described. Finally, the certification requirements and the reactor training text are outlined. (D.L.C.)

Propulsion and Space

4831 (ASD-TDR-63-428(Pt.I)) SPACECRAFT ELECTRIC GENERATING AND PROPULSION SYSTEM INTEGRATION STUDY. PART I. SYSTEM INTEGRATION STUDIES. Harold Brown, ed. (General Electric Co. Spacecraft Dept., Cincinnati). May 1963. Contract AF33(657)-8488. 205p.

Results are given of a spacecraft-electric-generating and propulsion-system integration study. This program consisted of the adaptation of the so-called LEADER technique to the analysis of nuclear-electric power and propulsion systems integration. Analytical models of each of the major components of a 350 kw spur-arc jet system and a 1 Mw spur-ion engine system were developed and processed by the LEADER optimization technique in order to demonstrate its capabilities for obtaining the design criteria for minimizing overall system weight. The specific output of the program included the optimum de-

sign variables, the constraints preventing further design improvement, and the sensitivity of the final design to subsequent changes in the independent design variables. (auth)

4832 (ASD-TDR-63-428(Pt.II)) SPACECRAFT ELECTRIC GENERATING AND PROPULSION SYSTEM INTEGRATION STUDY. PART II. LEADER USER'S MANUAL. Harold Brown, ed. (General Electric Co. Spacecraft Dept., Cincinnati). Apr. 1963. Contract AF33(657)-8488. 169p.

A description is given of the analytical techniques and computer programming effort required to develop an analytical model of a spacecraft electric generating and propulsion system and to incorporate the model into the so-called LEADER system optimization program. The review is structured to serve as a manual for potential users of the LEADER technique in order to facilitate their usage of the technique. Examples from the results of the spacecraft electric generating and propulsion system integration study are used to help demonstrate the various aspects of the LEADER technique. (auth)

4833 (LAMS-2966) KIWI B-1B CONTROL SYSTEMS. TEST CELL "A." Elliot Rappaport (Los Alamos Scientific Lab., N. Mex.). Feb. 1963. Contract W-7405-eng-36. 172p.

The automatic control systems for KIWI B-1B, Test Cell A, are discussed. For each system discussed, an analysis is included which gives a simplified mathematical model and the controls required. The mathematical system model is then built of analog computer components so that the controls can be checked out. Some approximations are necessary to work within the hardware constraints. (auth)

4834 (NUS-144) ENVIRONMENTAL SAFETY ASPECTS OF NUCLEAR ROCKET FLIGHT OPERATIONS. Semi-Annual Progress Report. (Nuclear Utility Services, Inc., Washington, D. C.). July 1963. Contract SNPC-6. 110p.

A preliminary evaluation of hazards from RIFT operations is studied with respect to environmental safety. Information is presented on source term, meteorological, and oceanographic data; fallout model and external beta dose considerations; demographic factors; radiobiological considerations in reentry of nuclear reactor fragments; internal dose considerations; computer program development; nuclear properties of uranium-235 fission products; and program schedules. (N.W.R.)

4835 (ORNL-3470(p.193-5)) SPACE POWER PROGRAM. W. C. Thurber (Oak Ridge National Lab., Tenn.).

Materials were evaluated and component-fabrication methods developed for some of the complex equipment required to demonstrate the feasibility of a boiling-potassium-cooled compact power reactor for use in space. Specific accomplishments include attachment of small-diameter thermocouples to electrical heaters, construction of large tapered-tube alkali-metal condensers, and brazing of bearings to shafts for rotating machinery. (auth)

4836 (SC-DC-3249) AEROSPACE NUCLEAR SAFETY RE-ENTRY FLIGHT TEST PROGRAM. A. J. Clark, Jr. (Sandia Corp., Albuquerque, N. Mex.). [nd]. Contract AT(29-1)-789. 20p. (CONF-311-6)

From American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex.

The purposes of the re-entry safety analysis program for nuclear power plants on spacecraft are outlined. The criteria and conduct of a re-entry test (RFD-1) are discussed. (T.F.H.)

4837 THE PROSPECTS OF NUCLEAR POWER FOR SHIP PROPULSION. K. Illies (Technische Hochschule, Hanover and Hamburg). Intern. Shipbuilding Progr., 9: 3-12(Dec. 1962).

The feasibility of nuclear power for commercial and naval shipping is discussed. The need, safety, and economy of nuclear power are discussed. (R.E.U.)

4838 NUCLEAR SPACE PROJECTS FACE UP TO SAFETY PROBLEMS. Harold L. Davis, ed. Nucleonics, 21: No. 12, 41-5(Dec. 1963).

Some safety aspects of the use of nuclear space power are discussed. The SNAP and Rover projects are discussed in terms of disposal of radioactive materials (both intended and accidental). The further complication of nuclear systems by added safeguards is discussed. (R.E.U.)

4839 NUKLEARNA PROPULZIJA. (Nuclear Propulsion). T. Bosanac. Belgrade, Novinsko-izdavačko Preduzeće "Export Press," [nd]. 86p.

The application of nuclear energy to propulsion is discussed. The basic principles involved in the operation of reactors are presented, followed by descriptions of applications for propulsion in the ice-breaker Lenin and the N.S. Savannah. The state of the art of nuclear ship propulsion is reviewed for the important maritime countries. The principles of nuclear rocket propulsion are also considered, with special attention to ion propulsion. Finally, the application of nuclear power for propelling aircraft and surface vehicles, such as locomotives, is mentioned. (TTT)

4840 LARGE TURBO-NUCLEAR SPACE POWER SYSTEMS. M. A. Zipkin (General Electric Co., Philadelphia). p.201-59 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The development of specific operating components for large space power systems has just begun. Programs are described for the turbine, pumps, and boiler. They typify the high degree of activity but at the same time emphasize the lack, as yet, of actual performance data. In addition, there are significant areas such as the radiator, in which component development is either inadequate or missing. There must be intensive component development if systems of high performance and reliability are to be achieved. Advances in basic technology are discussed. The basic technology is almost adequate for present system concepts but much more detailed data are needed to support the component test programs throughout their complete development cycle. A one-Mw system is depicted which is more than a conceptual design. The cycle is firm, the working fluid choices are narrowed to only a few alkali metals, the construction materials are in sight, the temperature is attainable, and the configuration workable. The dimensions and weight are practical, and the predicted performance can be achieved. Reliable, flight-worthy, high-power nuclear turbogenerators in space can become a reality within this decade. (auth)

4841 GASEOUS CORE REACTORS. Robert V. Meghreblian and Henry J. Stumpf (California Inst. of Tech., Pasadena). p.293-339 of "Advanced Propulsion Concepts. Vol. I." New York, Gordon and Breach Science Publishers, 1963.

The nuclear rocket is potentially capable of much higher specific impulse than any chemically fueled rocket, because of the high energy content per unit mass of the fissionable material. The full potential can be realized only if the fissionable material can be retained in gaseous form, and its fission energy transferred to the propellant without

the interposition of any solid surface. An idealized reactor model is postulated in which the nuclear fuel-bearing medium of the reactor consists of 2 basically different forms. In one region the system is temperature-limited in the usual sense, and in the other no constraint is imposed as to a maximum allowable temperature and the nuclear fuel and propellant are in the gaseous state. The various gaseous-core reactor concepts proposed thus far are considered. These include the vortex containment technique, which requires intimate mixing of the fissionable species and the propellant, and the plasma-core and coaxial-flow reactor concepts, both of which postulate the physical separation of the fuel and propellant. In the vortex technique the heat transfer is achieved by direct slowing down of the nuclear fission fragments in the propellant gas, whereas in the last 2 methods mentioned, the fission fragments slow down in the fuel region, which then transfers its energy to the propellant principally by thermal radiation. The non-temperature-limited reactor concept is combined with an engine complex, which includes a radiator. The incentives for developing gaseous-core reactors and some of the complex technical problems, which must be solved if such devices are ever to become a reality, are discussed. (auth)

4842 NUCLEAR RAMJET MISSILE FLIGHT SAFETY. W. J. Hesse and J. E. Standefer (Ling-Temco-Vought, Inc., Dallas). 25p. (CONF-311-2)

From American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

An attempt is made to show that nuclear ramjet missiles can be safely flight-tested at supersonic speeds and low altitudes without increasing present levels of contamination and without exposure of personnel to radiation in excess of recommended levels. The Pluto program and the Tory IIA and IIC reactors are discussed. (R.E.U.)

4843 APPLICATION OF NUCLEAR ROCKET PROPULSION TO MANNED MARS SPACECRAFT. Thomas F. Widmer. 19p. (CONF-308-1)

From American Institute of Aeronautics Meeting on Engineering Problems on Manned Interplanetary Exploration, Palo Alto, Calif., Sept. 1963.

The application of nuclear rocket propulsion to a manned interplanetary spacecraft is examined in terms of vehicle integration problems. Payload and velocity requirements for Mars round trip missions are used to establish the propulsion system constraints. Graphite and metallic reactors are considered, and the effects of engine restart capability upon mission profile and vehicle configuration are included. Vehicle preliminary designs were prepared to study compatibility with Saturn V launch vehicles and Earth orbital assembly. A reference design is described in detail for the case of a four man crew and 15 months total mission duration. (auth)

4844 GROUND TRANSPORTATION OF NUCLEAR PROPULSION STAGES. P. L. Marjon (AMF Atomics, Inc., New York). 26p. (CONF-297-3)

From International Conference and Exhibit on Aerospace Support, Washington, D. C., Aug. 1963.

The results of studies on transportation problems associated with the development and testing of nuclear rocket powered space vehicles at the static test size are presented. Factors involved in selecting a transport mode are discussed. Radiation shutdown considerations and a conceptual transporter capable of handling test articles of foreseeable size are examined. (D.C.W.)

4845 SPACE MAINTENANCE OF NUCLEAR ROCKET PROPULSION VEHICLES. P. L. Marjon (AMF Atomics, Inc., New York). 23p. (CONF-297-2)

From International Conference and Exhibit on Aerospace Support, Washington, D. C., Aug. 1963.

Maintenance and repair of spacecraft are discussed from the hardware viewpoint. Interior operations are rather straight forward, but study results show that space suits are not sufficient for exterior repair work. Evaluation of worker requirements leads to a maintenance capsule concept. Capsule application is depicted in contrasting situations: repair of meteoroid damage and nuclear engine replacement. Radiation shielding is also considered. (D.C.W.)

Research and Test Reactors

4846 (CONF-243-9) PREPARATION FOR OPERATION OF THE HFIR. R. V. McCord (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 28p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A discussion is presented, in the light of 20 years of reactor-operation experience at ORNL, of what is being done in preparation for operation of the HFIR. Only the areas of staffing and training; development of operating and maintenance procedures; preoperational testing of water systems; and testing of remote handling tools are considered. The preparatory work in other areas such as the hydraulic tests, neutron tests, etc., is not covered. (auth)

4847 (CONF-243-20) STAFFING EXPERIENCE FOR OPERATION OF THE PLUTONIUM RECYCLE TEST REACTOR. D. R. Koberg (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 23, 1963. Contract AT(45-1)-1350. 7p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A brief survey is presented of the staffing experience of the PRTR Operating Group. The original staffing and the present staffing are described together with the training programs. The organization structure is given. The turnover problems and the academic background of the personnel are considered. (D.L.C.)

4848 (EANDC(OR)-26U) INVESTIGATIONS ON THE EFFECT OF A SPLIT REACTOR-CORE ON THE PURITY OF THERMAL NEUTRON BEAMS. M. Tisljar and F. Woloch (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf, Austria). [1962]. 14p.

The effect of a split core upon the ratio (thermal/fast neutron flux) and upon the gamma ray intensity at the beam hole exit of a light-water moderated swimming pool reactor was studied. For this purpose, the fuel elements were placed symmetrically with respect to a layer of graphite moderator. Compared to an unsplit core, the graphite layer increased the ratio Φ_{th}/Φ_f by a factor $F_C \sim 10$. Due to the graphite layer, the gamma ray intensity was reduced by a factor of 2.5. In order to compare the effect of other moderators with that of graphite, a theoretical calculation of the improvement factor V_X (ratio between $\Phi_{th}/(\Phi_f + \Phi_{epi})$ for a split core with moderator X and an unsplit core) was made for the moderators C, Be, and D_2O, based on a two-group calculation in which the epithermal flux is treated together with the fast flux. (auth)

4849 (GA-4599) PLUTONIUM-FUELED, BERYLLIUM OXIDE-MODERATED REACTORS. R. K. Lane and A. J. Goodjohn (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 28, 1963. Contract AT(04-3)-187. 10p. (CONF-187-15)

From American Nuclear Society Meeting, New York, Nov. 1963.

Also included in TID-7682.

Studies indicated that a BeO-moderated, plutonium-fueled core composed of relatively simple homogeneous fuel elements can obtain high burnups with minimum reactivity changes. In addition, the moderating characteristics of the system are such that relatively easily obtainable fuel may be used. A 9.3-ft core was calculated to contain about 20 kg of Cm at the end of 1900 days of full-power operation. (P.C.H.)

4850 (ORNL-TM-290) A STUDY OF THE SHIELD OF THE VIRGINIA POLYTECHNIC INSTITUTE UTR-10 REACTOR. T. V. Blosser and R. M. Freestone, Jr. (Oak Ridge National Lab., Tenn.). Dec. 11, 1963. Contract W-7405-eng-26. 19p.

A study of the radiation leakage from the shield of the Virginia Polytechnic Institute UTR-10 reactor was completed. Fast-neutron, thermal-neutron, and gamma dosimeters of high sensitivity were employed to obtain a detailed network of data over all surfaces of the shield. Supplementary experiments evaluated gamma dose rates in a corridor and in a classroom adjoining the reactor room and also determined a rough value for argon dispersal through the reactor room ventilating system. The results of the detailed survey showed generally satisfactory performance of the shield for fast- and thermal-neutron radiations, but a number of regions were identified in which the gamma dose rate was higher than that predicted by the shield design. (auth)

4851 (ORNL-TM-332) A RADIATION STUDY OF THE WESTINGHOUSE TESTING REACTOR. T. V. Blosser and R. M. Freestone, Jr. (Oak Ridge National Lab., Tenn.). Dec. 11, 1963. Contract W-7405-eng-26. 26p.

Gamma-ray, fast-neutron, and thermal-neutron dose rate measurements utilizing instruments of high sensitivity have been made over a major portion of the biological shield of the Westinghouse Testing Reactor (WTR) at Waltz Mill, Pennsylvania. Observed rates were well below the rate of 1 mr/hr predicted for the shield for a reactor power of 60 Mw. Selected regions of the area within the W.T.R. security fence were examined to determine radiation levels due to gamma-ray "shine" from the elevated primary coolant tank. Dose rates ranging from 0.08 to 10 mr/hr were observed. The existence of a considerable fast-neutron flux in the reactor coolant exit stream at distances as great as ~245 ft from the core was established, but the source for these neutrons was not definitely determined. (auth)

4852 (UCRL-7335) FUEL MANAGEMENT FOR AN INTERMEDIATE POWER RESEARCH REACTOR. Ernest E. Hill (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 1963. Contract W-7405-eng-48. 16p. (CONF-243-30)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The results of operating the Livermore Pool Type Reactor (LPTR) on a fuel cycle program initiated in 1960 are reviewed. The general operational philosophy pertaining to fuel management and excess reactivity management is discussed. The original fuel cycle program is modified in several respects. These modifications and their effect on the overall fuel management program are included. The results of three years (32 cycles) of operation are shown with the U^{235} mass, fission product mass, thermal utilization, and percent burn at the start of each cycle. Finally, the direct relationship of the thermal utilization to the number of megawatt days per cycle is shown for the range of interest on the LPTR. (auth)

4853 (UCRL-7353) CONTROL ROD CALIBRATION AND XENON POISONING STUDIES AT THE LPTR. Stephen A. Massey (California. Univ., Livermore. Lawrence Radiation Lab.). May 13, 1963. Contract W-7405-eng-48. 31p. (CONF-243-31)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Experimental and digital computer code investigations of xenon poisoning are discussed. A technique for control rod calibration as the fission product poisoning builds up to an equilibrium value during reactor operation is presented, and experimental results obtained with an intermediate-power research reactor (LPTR) are included. Results of point-reactor poisoning codes are given in graphical form. The curves illustrate the effect of varying fission yields and neutron-absorption cross sections upon fission-product poisoning values before and after shutdown of a reactor. (auth)

4854 (UCRL-7513) CHARACTERISTICS OF THE LPTR FAST NEUTRON IRRADIATION FACILITY. Garth E. Cummings and Gordon V. Pefley, Jr. (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 20, 1963. Contract W-7405-eng-48. 14p.

The fast neutron irradiation facility put into operation at the Livermore Pool Type Reactor was designed to irradiate samples in a neutron flux having an energy distribution approximating a U^{235} fission spectrum. Two uranium-aluminum alloy plates convert the thermal neutrons (from a graphite thermal column) to fission energy neutrons, yielding a flux between 10^{10} and 10^{11} n/cm^2-sec in the sample location. The air-cooled plates produce 900 w of power with the LPTR at a nominal power level of 2 Mw. (auth)

4855 MEASUREMENT OF THE FREQUENCY RESPONSE OF THE IRT-1000 TYPE REACTOR BY MEANS OF THE OSCILLATOR METHOD. L. V. Konstantinov, A. I. Efanov, and V. V. Postnikov. At. Energy. (USSR), 15: 332-4(Oct. 1963). (In Russian)

Analysis of the reactor noise for determining the frequency response presents computational difficulties; therefore, an oscillator method was developed which allows the frequency response of the IRT-1000 type reactor to be measured in the frequency range from 0.3 to 60 hertz by means of a device without electronic components. The measurements involved the determination of the amplitude and the phase of the reactor power oscillations on the basis of the sinusoidal variations of the reactivity. The reactivity oscillator, placed in the reactor reflector, consisted of 5 Cd shutters, rotation of which caused a sinusoidal change in the absorbing surface, with similar variations of the reactivity. The high sensitivity of the galvanometer made amplification of the signal unnecessary. The measurements were carried out at a reactor power of 1500 kw and reactivity oscillations of $\delta k_0 = 4 \times 10^{-4}$. The obtained amplitude frequency response of $(7.3 \pm 0.3) \times 10^{-5}$ sec agreed within the limits of the experimental error with the calculated value of 7×10^{-5} sec.

The phase-frequency response differed from the theoretical values at frequencies beyond 10 hertz. The difference is probably due to the presence of the reflector in the reactor. (TTT)

4856 PROTECTION AGAINST RADIATION ORIGINATING FROM THE KEMA SUSPENSION TEST REACTOR (KSTR). [PART] II. Hub. Wijker. Atoomenergie Haar Toepassingen, 5: 199-206(Oct. 1963). (In Dutch)

The dispersal of gases from the stack of the KEMA Suspension Test Reactor was discussed. The containment and storage of radioactivity are briefly considered. (tr-auth)

4857 ADVANTAGES AND DISADVANTAGE OF THE VARIOUS TYPES OF RESEARCH REACTOR. I. GENERALITIES. C. Chauvez. Bull. Inform. Sci. Tech. (Paris), No. 75, 9-10(Aug.-Sept. 1963). (In French)

The advantages of using common moderators in research reactors are considered from a general point of view. Competition appears especially between heavy and light water; in the first case, the advantages reside mainly in the possibility of obtaining higher performances, while in the second case they are essentially of a practical order. (auth)

4858 ADVANTAGES AND DISADVANTAGE OF THE VARIOUS TYPES OF RESEARCH REACTOR. II. HEAVY WATER REACTORS. P. Delattre. Bull. Inform Sci. Tech. (Paris), No. 75, 11-14(Aug.-Sept. 1963). (In French)

The advantages of using heavy water as a moderator must be considered first of all, when the reactor fuel is natural uranium, for the following parameters: critical mass, control, conversion factor, influence of burnup on reactivity, and volume available for experiments. With enriched uranium, all these advantages exist. When very undermoderated systems are needed, the superiority of heavy water is shown to be undeniable. The disadvantages of heavy water reactors lie in the rather important investments which are needed and in the complexity of operational problems. (auth)

4859 ADVANTAGES AND DISADVANTAGE OF THE VARIOUS TYPES OF RESEARCH REACTOR. III. LIGHT WATER REACTORS. G. Denielou and F. Rossillon (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 15-18(Aug.-Sept. 1963). (In French)

The large number of light water moderated reactors now operating throughout the world shows the interest in that kind of reactor. Even if heavy water were as cheap as light water and only required installations as simple as those necessary for light water, it is not sure that the light water moderated reactors would not have advantages. After these general considerations, the different types of light water reactors were examined: swimming pool with open core, with closed core, with tank, "well" type, fueled with "bottle type" elements. The time needed for the carrying out of experiments is considered. (auth)

4860 THE DIFFERENT TYPES OF EXPERIMENTS. P. Delattre and J. Lalère. Bull. Inform. Sci. Tech. (Paris), No. 75, 19-22(Aug.-Sept. 1963). (In French)

Various in-pile experiments were classified in a few basic groups. Such a classification makes it possible to define some fundamental technical problems and to facilitate the designing of new research reactors. Eight basic groups are defined. For each one, a short description is given pointing out the major technical problems involved. (auth)

4861 THE DETERMINATION OF THE EXPERIMENTAL CONDITIONS. J.-P. Genthon. Bull. Inform. Sci. Tech. (Paris), No. 75, 23-7(Aug.-Sept. 1963). (In French)

Experimental techniques require development of methods that are able to determine as accurately as possible the physical parameters imposed on the experiment. On the quality of this determination depends the quality of the experiment and its interpretation. A description is given of the various methods of calculation and measurement, their limitations, and mixed methods allowing calculation and measurement that make it possible to determine the parameters required. These parameters are the specific powers, temperatures, instantaneous values, integrated doses, and energy spectra of thermal flux, intermediate and fast flux, equivalent damage flux, and γ radiation. (auth)

4862 SAFETY OF IN-PILE EXPERIMENTS. J.-J. Graf, J. Lalère, and E. de Robien. Bull. Inform. Sci. Tech. (Paris), No. 75, 29-31(Aug.-Sept. 1963). (In French)

The importance of safety problems related to in-pile experiments is emphasized. The way of approaching these problems and the consequences involved so far as the experiments and the research reactor in which these experiments are carried out are concerned are discussed. Considerations concerning the evolution of these problems during the last few years are presented. (auth)

4863 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. I. THE EL-2 REACTOR. A. Goinguenet and R. Senaux. Bull. Inform. Sci. Tech. (Paris), No. 75, 33-5(Aug.-Sept. 1963). (In French)

After a summary of the characteristics of the research reactor EL-2, a review of its importance for radioisotope production and for studies in fundamental physics, physicochemistry, and technology is given. (auth)

4864 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. 2. THE EL-3 REACTOR. B. Clément, J. Bureau du Colombier, and G. Garcin. Bull. Inform. Sci. Tech. (Paris), No. 75, 37-40(Aug.-Sept. 1963). (In French)

Five years operation at high power of the research reactor EL-3 have allowed it to be used for various research projects. The principal kinds of irradiations or experiments carried out in the fields of physics, biology, physico-chemistry, engineering, metallurgy, and radioisotope production are reviewed. (auth)

4865 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. 3. THE REACTOR TRITON. J. Gilbert and R. Beauge. Bull. Inform. Sci. Tech. (Paris), No. 75, 41-5(Aug.-Sept. 1963). (In French)

Triton I is a 2-Mw swimming-pool reactor, fueled with MTR type elements, and located at Fontenay-aux-Roses. For experimental purposes, it offers 4 horizontal channels and numerous vertical spaces on the core grid: two are inside the core with a fast neutrons flux of over 10^{13} $n/cm^2/sec$ and nearly twenty are on the core periphery, with a fast neutrons flux of 3×10^{12} $n/cm^2/sec$ and a thermal neutrons flux of 2×10^{13} $n/cm^2/sec$. High-fast and epithermal neutron fluxes are used especially for structural materials and graphite irradiations. Easy shielding and handling also allow irradiations of short duration and in variable fluxes, either in the liquid nitro-

gen loop or on another grid. This reactor also produces radioisotopes. (auth)

4866 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. 4. THE REACTOR MÉLUSINE. P. Plum (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 47-51(Aug.-Sept. 1963). (In French)

The characteristics of the reactor Mélusine and the modifications and improvements that were made after the first operating cycles are described. The normal program of the reactor is outlined and the experiments under way (beam-tubes, cold loops, organic liquid loops, high temperature irradiations, etc.) are listed. (auth)

4867 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. 5. THE REACTOR SILOE. G. Mitault and P. Millies (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 53-7(Aug.-Sept. 1963). (In French)

The reactor Siloe is a swimming-pool reactor (open core and its normal power is 10 Mw. A description of the core, experimental devices, various supply circuits, and hot cell for dismantling is given. Fuel elements are of the MTR type (plane plates bundle with 18 plates in each element); the uranium is 90% enriched. Projected experiments are described both from the fundamental research and the applied research points of view. (auth)

4868 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. 6. THE REACTOR PÉGASE. Bull. Inform. Sci. Tech. (Paris), No. 75, 59-66(Aug.-Sept. 1963). (In French)

The principal purpose of the Pégase reactor (30 Mw) is to test in real operating conditions fuel elements designed for gas-cooled power reactors. The basic criteria of the design are explained. Several autonomous loops can be located around a very concentrated core; they are removable: a tested fuel element can be removed without any notable effect on reactor operation; this presents possibilities never before obtained in a research reactor. (auth)

4869 THE RESEARCH REACTORS USED BY THE CEA. A BRIEF REPORT ON THE REACTOR CHARACTERISTICS AND INDICATIONS ON THE GENERAL PROGRAM FOR USE. 7. FRENCH EXPERIMENTS IN FOREIGN REACTORS. J.-P. Genthon, J. Rousseau, J.-M. Descamps, and G. Naudet. Bull. Inform. Sci. Tech. (Paris), No. 75, 67-73(Aug.-Sept. 1963). (In French)

The reasons that led the C.E.A. to carry out irradiation experiments in foreign reactors are described. These are: collaboration between specialists, collaboration in the use of a reactor, and the need for high fast neutrons flux which are not available in French reactors, that is, a fast flux able to give integrated doses of several times 10^{21} n/cm^2 in a relatively short time. C.E.A. experiments in the three most used reactors, BR 2 in Belgium, RA in Yugoslavia, and HFR in the Netherlands are described. Brief descriptions of the experimental facilities which the C.E.A. used are followed by a description of the main characteristics of actual and projected irradiations. (auth)

4870 LOW-TEMPERATURE IRRADIATION EQUIPMENT IN THE REACTOR MÉLUSINE. J. Doulat and J. Le Calvez (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 75, 77-9(Aug.-Sept. 1963). (In French)

The various devices for low-temperature irradiation that were built in the Centre d'Études Nucléaires de Grenoble are described. Irradiations at liquid-nitrogen temperature (78°K) were carried out, now it is possible to operate at liquid–hydrogen temperature (28°K); in this case it is necessary however, for safety reasons, to separate the irradiation bath (liquid neon) from the cooling circuit. (auth)

4871 CARBON DIOXIDE LOOP FOR THE IRRADIATION OF FUEL SAMPLES. L. Ezran. Bull. Inform. Sci. Tech. (Paris), No. 75, 81-4(Aug.-Sept. 1963). (In French)

A CO_2 loop was built to allow irradiation at high temperature of enriched uranium and plutonium samples. This loop, located in the channel H^5 of reactor EL-3, began operation in 1959. Samples are in a thermal neutrons flux of 3×10^{13} n/cm^2/sec; their temperature is maintained at a constant level by changing the rate of coolant flow. (auth)

4872 LOOP AND RIG FOR PRESSURE IN-PILE TESTS OF TUBULAR SPECIMEN CREEP. G. Lachèse and J. Lamaire. Bull. Inform. Sci. Tech. (Paris), No. 75, 85-90(Aug.-Sept. 1963). (In French)

In order to study in-pile creep on canning materials of gas-cooled power reactors, an apparatus was designed for tubular specimens, under pressure of carbon dioxide obtained from an automatic system of distribution consisting of gas cylinder, expansion valve, and electric cocks. The apparatus allows the simultaneous study of four sets of at most five samples, at various temperatures between room temperature and 700°C and at stresses of from 0 to 2 ton/in^2 (time to rupture between 500 and 1,500 hours). The out-of-pile loop is made up of the system of pressure distribution, the system of heater regulation, and the checks, recordings, and safety devices that are described. (auth)

4873 TESTS LOOPS FOR FULL-SIZE FUEL ELEMENTS IN THE PÉGASE REACTOR. Bull. Inform. Sci. Tech. (Paris), No. 75, 115-19(Aug.-Sept. 1963). (In French)

Eight loops can be simultaneously irradiated in the Pégase reactor. There are two types of loops: the first is for tests of EDF fuel elements and the second is for tests of EL-4 fuel elements. The parts of these two classes of devices and their principal characteristics are described. (auth)

4874 BEHAVIOR OF VOID COEFFICIENTS IN A SWIMMING POOL REACTOR. R. Galvagni, A. Markovina, L. Pucciarelli, and R. Scafe. Comit. Nazl. Energia Nucl., Notiziario, 9: No. 10, 31-7(Oct. 1963). (In Italian)

The behavior of voids in a swimming pool reactor was discussed. The coefficients were determined both for a central void and a uniform reactor. (auth)

4875 THE PEGASE AND SILOE (ATOMIC PILES). Yves Mériel. Nature (Paris), No. 3338, 242-4(June 1963). (In French)

The Siloe and Pegase reactors, which achieved criticality in March and April of 1963, respectively, are described. Particular attention is given to the Pegase facility, and only the general parameters of Siloe are outlined. (T.F.H.)

4876 RECENT DEVELOPMENT IN CHEMISTRY RESEARCH AND CHEMICAL TECHNIQUES BASED ON RESEARCH REACTOR. Reinosuke Hara (International Atomic Energy Agency). Nippon Genshiryoku Gakkaishi, 5: 862-9 (Oct. 1963). (In Japanese)

Basic developments in reactor-based chemical research and techniques are discussed with specific reference to isotope production, activation analysis, fission chemistry, hot-atom chemistry, radiation chemistry, neutron converters, in-pile gamma loops, and reactor pulse. Special reactors such as pulsed reactors and high-flux reactors are discussed with respect to their role in future research. (auth)

4877 ANALYSIS OF TRANSIENT BEHAVIOR IN THE SPERT-I REACTOR. Shigenori Hayashi, Akira Sakurai, Tetsuo Iwazumi, Hideto Aoki, Motohiko Kitamura, and Jiro Wakabayashi. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 11: No. 4, 51-63(Mar. 1961).

The analysis is based on the conduction boiling model. The design data of SPERT-I and some experimental results concerning transient heat transfer and transient boiling are used so that the analytical method can be applied to the analysis of experiment and the preestimation of transient behavior of reactors. In the analysis of water-moderated reactors, it is shown that the transient heat transfer before boiling, heat transfer, from fuel to aluminum cover, delay time of boiling, boiling temperature rise due to pressure rise, and the lifetime of bubbles are important factors. (R.E.U.)

4878 CONTROL EQUIPMENT FOR JAPAN RESEARCH REACTOR-III. Etsuro Ashihara, Takahisa Masuda, et al. (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Intern. Ed., 18: 583-94(May 1963). (In Japanese)

The Japan Research Reactor, JRR-3, is a 10-Mw natural uranium heavy-water-moderated reactor. It became critical on September 12, 1962, and is now under low-power tests. The nuclear instrumentation and control system of the reactor are described. (auth)

4879 STOCHASTIC PROCESSES IN COUPLED NUCLEAR REACTOR CORES. Henri Romain Leribaux. Thesis, Ames, Iowa, Iowa State Univ., 1963. 161p.

A theoretical and experimental analysis of stochastic or random processes occurring in the UTR-10 reactor containing two coupled fuel-bearing regions is discussed. The experimental analysis includes a determination of the auto-correlation function of the neutron density fluctuations both by digital computing and by analog computing methods. The theoretical work includes an analysis of the second order moments (auto- and cross-correlation functions) of the random fluctuations of the observable variables (especially the neutron density fluctuations in the two multiplying regions), under the influence of multiple microscopic sources of fluctuations corresponding to the fission (or productive absorption) process, to the destructive absorption process and to an exchange process (whereby neutrons are exchanged between the two multiplying regions). A matrix formulation of the second order moments of the observable variables in terms of the same moments of the microscopic sources of fluctuations makes possible to determine the correlation functions of all observable variables. An analogy with the generalized electron shot effect was carried out for each microscopic source of fluctuations in order to determine their relative importance. A solution was carried out in the frequency domain (for the power spectral densities). The power spectral density of the neutron density fluctuations in each multiplying region and the cross-power spectral density between neutron density fluctuations of both regions were the solutions analyzed. The corresponding auto- and cross-correlation functions were determined as inverse Fourier transforms of the preceding solutions. The correlation functions were found to be linear combinations of exponential functions of the time lag. In the experimental work, an auto-correlation analysis of the neutron density fluctuations in one multiplying region was performed, by a discrete method of analysis (with a digital computer). The distinctive feature was the use of a high-speed recording camera to obtain the sampled data sequences necessary for an accurate correlation analysis (with a dispersion smaller than 5.5%). The auto-correlation analysis was performed at various operating power levels of the reactor; in each case, the correlation function was a very smooth, exponentially behaved function of the time lag. Another determination of the previous auto-correlation function was made in the frequency domain (through the corresponding power spectral density), by an analog and continuous method of analysis, known as the filtering-rectifying-smoothing method (in information theory). The resulting power spectral density corresponds closely to the expected Fourier transform of the previously determined auto-correlation function of the neutron density fluctuations in the same multiplying region. Values of the mean generation time of neutrons in the reactor analyzed were derived from the results of both methods of analysis and were found to be in good agreement. By the last method of analysis, the power spectral density was found to be closely proportional to the steady-state operating level of the reactor (in agreement with the analytic results). (Dissertation Abstr., 24: No. 4, Oct. 1963)

4880 MONITORING AND DETECTION OF FISSION PRODUCT RELEASE AT A 5MW RESEARCH REACTOR. Kenneth W. Skrable (Columbia Univ., Plainsboro, N. J.). 32p. (CONF-243-33)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The reactor cooling and off-gas systems and the equipment and procedures with which airborne radioactivity is detected and monitored are described. Results on the identification of airborne fission products and the levels of activities show that monitoring of airborne activity for fission products is a very sensitive means for detecting fission product release at the reactor. Information on the origin of activities and their relation to U^{235} exposure is included. (D.C.W.)

4881 ADMINISTRATION PROBLEMS OF RESEARCH REACTOR OPERATION. W. H. Lunning (Dounreay Experimental Reactor Establishment, Caithness, Scotland). 8p. (CONF-243-14)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Some administrative problems at the Dounreay Materials Testing Reactor facility are discussed. The problems of the research group are divided into safety and utilization. (R.E.U.)

4882 A REPORT ON THE DEFORMATION OF THE FORD NUCLEAR REACTOR SHIM-SAFETY RODS. J. B. Bullock (Univ. of Michigan, Ann Arbor). 13p. (CONF-243-15)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

An incident at FNR in August, 1960, is reported in which one of the reactor's three shim-safety rods swelled and jammed in the core. The preoperational testing and evaluation of a new shim-safety rod design is summarized. The operational history of the new rods is reported. (R.E.U.)

4883 SECONDARY AND TERTIARY CONTAINMENTS TO WALTER REED RESEARCH REACTOR (WRRR). James B. Smathers and Dan Hightower. 10p. (CONF-243-17)

From American Nuclear Society Conference on Problems

of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The problem of sealing of the secondary and tertiary systems in WRRR is discussed. The maximum credible accident, simultaneous breaching of the primary and secondary enclosures with release of fission products, is considered in the tertiary containment requirements. (R.E.U.)

4884 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Roger Chabassier, Gerard Dupuy, Bernard Lerouge, and Jean Megret (to Commissariat à l'Energie Atomique). British Patent 943,755. Dec. 4, 1963. Priority date May 20, 1960, France.

A self-contained, readily dismantled and positioned loop for irradiating materials in a swimming pool reactor under defined conditions of temperature and pressure and in a definite ambient medium is described. The sample rests in a vertical tube segment; and the gas, circulating in a closed circuit, cools it. A heat exchanger cools the gas. (D.C.W.)

WASTE DISPOSAL AND PROCESSING

4885 (CEA-2331) ENROBAGE PAR LE BITUME DES BOUES RADIOACTIVES DE LA STATION DE TRAITEMENT DES EFFLUENTS DU DENTRE DE MARCOULE. Mise au point des états d'avancement 1, 2, 3 et 4. (Bitumen Coating of the Radioactive Sludges from the Effluent Treatment Plant at the Marcoule Center. Review of the Progress Reports 1, 2, 3, and 4). J. Rodier, G. Lefillatre, and J. Scheidhauer (France. Commissariat à l'Energie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). 1963. 135p.

Evaporation, resin concentration, and coprecipitation techniques for the processing of highly active liquid wastes give rise to inorganic sludges with a high water concentration. The preliminary studies undertaken on the bitumen coating of the radioactive sludges from the effluent treatment plant at Marcoule are reviewed. The properties of bitumen and of the radioactive sludge are first described. The principle of the bitumen coating of sludge is discussed. A one-stage and a two-stage process for the coating and the quality of the coating resulting from each process are described. The activity of the liquid wastes and the atmospheric contamination resulting from the bitumen coating are determined for both processes. The problems of bitumen coating are discussed. (J.S.R.)

4886 (HW-79140) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, July–September 1963. E. R. Irish, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 44p.

The radiant-heat spray calciner in the High-Level Radiochemistry Facility was used for additional experimental studies of full-level Purex 1WW calcination. The unit was operated with ammonia-neutralized Purex waste plus sugar, acidic Purex waste with phosphate added, and with sugar added. Behavior of ruthenium and properties of the melt were observed. A tracer I^{131} run was made in the 8-inch diameter cold calciner to evaluate iodine behavior during calcination. The large Cold Semiworks spray calciner was operated for further evaluation of the calciner capacity and heat-transfer characteristics. Development of glass processes was initiated with installation and operation of a continuous melter for calcine powder. An elaboration on the sugar denitration process for Purex 1WW is provided. Experimental runs were made with a model annular circulator proposed for in-tank solidification of intermediate-level plant wastes to determine heat-transfer characteristics. Details of the engineering work on dehydration of fission product-loaded zeolites were documented. Equilibrium constants and free energies were determined for two exchange reactions on six exchangers. Zeolites with low silica-to-alumina ratios exhibited the highest strontium selectivity. Breakthrough curves for strontium on Linde 4A zeolite were predicted on the basis of plate theory and compared to experimentally determined curves. The calculated and experimental curves show close agreement. Work continued on defining flowsheet conditions for removal of cesium from Purex and Redox wastes. Experimental work is underway to evaluate electrodialysis as a processing technique for treatment of low- and intermediate-level wastes. Pilot plant solvent extraction studies were continued on the development of CSREX and D2EHPA processes for removal of long-lived heat-generating fission products from Purex wastes. Pulse column design details are presented. (auth)

4887 (LAMS-2937) RADIOACTIVE GASEOUS EFFLUENTS FROM A HOMOGENEOUS REACTOR. Dale E. Hankins (Los Alamos Scientific Lab., N. Mex.). June 1963. Contract W-7405-eng-36. 45p.

Presented are the radioactive isotopes and the concentration of these isotopes in the effluent gases released from the Water Boiler reactor stack. The effect of prior operation of the Water Boiler reactor on the relative concentrations of the various isotopes is discussed. An evaluation is made of the results of an additional delay in the stack line. The curie output through the stack for each major isotope following a normal reactor operating day is given. (auth)

4888 (NP-13289) TESTS FOR THE EUROCHEMIC "HOT WASTE" EVAPORATOR. A. Redon and F. Marcus (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Mar. 1963. 81p. (ETR-140)

Details are given of the experimental program carried out by A. B. Atomenergi to supply data required for the design of an evaporator for treating "hot wastes" from the Eurochemic plant. The investigations showed that a decontamination factor of between 10^7 and 10^8 (based on uranium) can be attained between the evaporator solution and the condensate. The test results give information about design and operation which will form an essential part of the evaporator specifications. (auth)

4889 (ORNL-3518) RECOVERY OF FISSION PRODUCTS FROM WASTE SOLUTIONS BY SOLVENT EXTRACTION. D. E. Horner, K. B. Brown, D. J. Crouse, and B. Weaver (Oak Ridge National Lab., Tenn.). Dec. 9, 1963. Contract W-7405-eng-26. 39p.

Increasing industrial, military, and space requirements for certain fission products place emphasis on large-scale methods for their recovery from waste liquors produced by the fuel recovery processes. With development of organic extractants for separating and recovering these fission products, solvent extraction offers a versatile alternative to ion-exchange, precipitation, and crystallization procedures heretofore used for small-scale recoveries. A process flowsheet was developed for the recovery of strontium and mixed rare earths from adjusted Purex 1WW solution by the use of di(2-ethylhexyl)phosphoric acid (D2EHPA). After adding tartrate to complex the iron and caustic to adjust the pH to 6, strontium and rare earths are co-extracted and then co-stripped with nitric acid in the first cycle. In additional D2EHPA extraction cycles, they are isolated as concentrated fractions. The mixed rare earths from this process can be treated by tributyl phosphate (TBP) extraction to separate the individual rare earth elements of which promethium and cerium are of greatest interest. Zirconium–niobium also may be recovered with D2EHPA from acidic waste liquors. An amine pretreatment extraction process was developed for removing nitric acid, iron sulfate, zirconium–niobium, and ruthenium from waste solutions to furnish a feed liquor more amenable to subsequent processes for recovering fission products. The separate recovery of ruthenium, zirconium–niobium, and rare earths may also be possible by amine extraction. A process based on the use of substituted phenols was de-

veloped for recovering cesium from alkaline waste solutions. These compounds are selective extractants for cesium, giving high decontamination from other fission products and sodium, and they are readily stripped with dilute nitric acid. Previous studies also outlined methods for recovering neptunium, plutonium, and technetium with solvents similar to those described. When appropriately combined, these developments offer a versatile integrated solvent extraction flowsheet for the recovery of all important fission products and other components from waste liquors. (auth)

4890 (PG-Report-500) THE BIOLOGY OF THE SOLWAY FIRTH IN RELATION TO THE MOVEMENT AND ACCUMULATION OF RADIOACTIVE MATERIALS. I. GENERAL INTRODUCTION. E. J. Perkins and B. R. H. Williams (United Kingdom Atomic Energy Authority. Production Group. Chapelcross Works, Annon, Dumfriesshire, Scotland). 1963. 16p.

An investigation was made of the Solway Firth, an inlet of the North East Irish Sea, designed to determine its capacity for the receipt of radioactive effluent. The general features of the area and its fisheries are described. The nature of the ebb-flood channel system is shown to be dependent upon the geology of the area. (auth)

4891 TREATMENT OF FISSION PRODUCT SOLUTIONS BY VITRIFICATION. [R.] Bonniaud, Brodsky, Burko, and [P.] Cohen. Energie Nucl., 5: 427-30(Sept.-Oct. 1963). (In French)

The treatment of irradiated atomic reactor fuels produces residues of very high specific activity, which makes their disposal into the environment impossible. Prolonged storage in liquid form is inconvenient. Of the different possible solidification methods, one of the most promising is the incorporation, after burning, into a homogeneous vitreous mass. Laboratory research on active solutions leads to the building of a continuous pilot plant, which is described. (auth)

4892 STUDY ON TREATMENT OF RADIOACTIVE LIQUID WASTE. K. Hirose (Tokyo Univ.), M. Sago, et al. Kuki Chowa, Eisei Kogaku, 37: 423-43(June 1963). (In Japanese)

Various methods for the treatment of low level liquid waste from radioisotope handling facilities such as hospitals, laboratories, and industrial factories were investigated. A new method was devised to determine the radioactivity of river water and laboratory effluents. A new type of holding tank was designed for the storage of low level liquid waste. Experiments were undertaken, moreover, on various ion exchange and adsorption methods for the removal of radioactive materials from the liquid waste. (auth)

4893 ON THE QUANTITY OF RADIOISOTOPES IN LIQUID WASTE AND SOME PROBLEMS WITH REGARD TO THE STORAGE TANK OF LOW LEVEL WATER. K. Hirose (Tokyo Univ.), M. Sago, et al. Kuki Chowa, Eisei Kogaku, 37: 444-50(June 1963).

Two concrete waste storage tanks with 10-cm wall thicknesses were fabricated. One was unlined; the other was lined with epoxy-resin paint. The tanks were filled with water containing P^{32} and I^{131}, respectively, and the leakage was monitored. After two months the amount of isotope adsorbed in the concrete wall was examined. In the first tank, though the seepage of water was found, no activity existed on the outside surface. However, examination of the concrete showed the activity reached almost to the outer surface. In the second tank no leakage was observed. It was concluded that tanks for liquid waste storage higher than MPC should be lined with some materials such as plastic paint. (auth)

4894 IMPROVEMENTS IN OR RELATING TO THE DISPOSAL OF RADIOACTIVE WASTE. Preston Lenell Gant, D'Arcy Adriance Shock, and John Dean Sudbury (to Continental Oil Co.). British Patent 940,254. Oct. 30, 1963. Priority date Feb. 24, 1961, United States.

A method of disposing of liquid radioactive waste in subterranean locations is patented. A well bore is drilled through an impermeable rock formation, and the rock formation is fractured at a depth to provide sufficient shielding for the radioactive waste. A stream of radioactive waste treated with a solidifiable material is injected into the fracture, preceded and followed by the solidifiable material free of radioactive waste to seal the waste in the rock formation. The solidifiable material consists of clay minerals, lime, and basic metal hydroxide. Check wells are located in the vicinity of the well bore to determine the extent and direction of the fracture. (M.P.G.)

GENERAL AND MISCELLANEOUS

4895 (ANL-6712) VARIABLY CURING RESINS FOR MOUNTING METALLOGRAPHIC SAMPLES. O. L. Kruger, J. P. Hughes, and F. J. Schmitz (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 38p.

In the past, heat-and-pressure-curing resins have been used almost exclusively as mounting materials for metallographic samples. Now, however, certain polyester resins, which are curable at room temperature, are equally as good for this purpose, and with their versatility they adapt readily to a variety of mounting conditions. A study of the epoxies and polyesters was made to determine which type of resin would satisfy the desirable properties of a metallographic mount. Four polyester resins were selected and investigated intensively to ascertain the variables associated with their curing processes. The results are compared with the standard thermosetting mounting material, Bakelite. (auth)

4896 (BNL-799) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, JANUARY 1–APRIL 30, 1963. Jean H. Reynolds, ed. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 114p. (BNL-S-64)

Separate abstracts were prepared for sections on reactor physics, chemistry and chemical engineering, radiation, hot laboratories, metallurgy, and engineering. (N.W.R.)

For abstracts of individual sections see: 3671, 3672, 3806, 4160, 4688, and 4689.

4897 (BNL-6870) A SERIAL AUTORADIOGRAPHIC ANALYSIS OF H^3-GLYCINE UTILIZATION AND DISTRIBUTION IN THE FEMORA OF GROWING MICE. E. A. Tonna, E. P. Cronkite, and M. Pavelec (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 50p.

The amino acid composition of collagen and the role of collagen in bone formation are reviewed. It is pointed out that glycine is the predominant amino acid of collagen. Results are reported from a serial, autoradiographic study of the localization and distribution of H^3 in the femora of young mice following the administration of H^3-glycine. The functional behavior and capacity of different skeletal cells in matrix production are discussed. (26 references.) (C.H.)

4898 (BNL-6910) PRIMARY AND SECONDARY ANTITOXIN RESPONSES IN THYMECTOMIZED MICE. Max W. Hess, Hans Cottier, and Richard D. Stoner (Brookhaven National Lab., Upton, N. Y.). [Apr. 11, 1963]. Contract AT(30-2)-Gen-16. 18p.

A total of 68 Swiss albino mice of either sex were thymectomized at the following time intervals after birth: 22 during day one, 21 during day two, 17 on day four and 8 on day eight. Sixty-one nonoperated litter-mates served as controls. All mice were given primary antigenic stimulation with adsorbed tetanus toxoids when four weeks of age. Three weeks later a booster injection of fluid tetanus toxoid was given. With these time intervals thymectomized mice showed only slightly impaired primary responses but severely repressed secondary responses as compared to nonoperated litter-mates. This uncommon finding is difficult to explain at present and results are discussed with regard to other reports on the effect of postnatal thymectomy on immune responses. Special emphasis is placed on the unknown effect of postthymectomy wasting syndrome. (auth)

4899 (BNL-6915) ON THE SPECTRAL THEORY OF SINGULAR INTEGRAL OPERATORS. Joel David Pincus (Brookhaven National Lab., Upton, N. Y.). [Apr. 10, 1963]. Contract AT(30-2)-Gen-16. 49p.

A complete spectral representation is given for a class of singular integral operators. The influence of spectral multiplicity is partially taken into account. (T.F.H.)

4900 (CONF-117-32) A MASS SPECTROMETRIC INVESTIGATION OF THE NICKEL, BROMINE SURFACE REACTION. John D. McKinley (National Bureau of Standards, Washington, D. C.). [1962]. 23p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Mass spectrometric measurements were made of the volatile products of the reaction between nickel and bromine at nickel temperatures between 300 and 1600°K, and at bromine pressures between 10^{-7} and 10^{-4} mm Hg. Bromine dissociates on the surface at a temperature-dependent rate; the fraction dissociated is much less than that corresponding to equilibration of the incident bromine with the hot nickel surface. $NiBr_2$ and NiBr are formed in surface reactions at rates proportional to the bromine pressure. The former product is formed between 600 and 1200°K with a maximum in the rate at 900°; the latter is formed above 1200° at a rate increasing with nickel temperature. (auth)

4901 (CONF-303-6) MÖSSBAUER STUDY OF THE MAGNETIC PROPERTIES OF THE Cr_2O_3–Fe_2O_3 SYSTEM. Scientific Paper 63-129-102-P3. M. Kuriyama, P. A. Flinn (Westinghouse Electric Corp. Research Labs., Pittsburgh); D. E. Cox, and G. Shirane (Brookhaven National Lab., Upton, N. Y.). Aug. 28, 1963. Contract [AT(30-2)-Gen-16]. 20p.

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

Mössbauer measurements were made on a number of solid solutions $(1-x)Cr_2O_3-xFe_2O_3$ ($x \leq 0.5$) in an attempt to obtain further information about the cone spiral structure that occurs in this system at low temperatures. In each case, a spectrum consisting of six well-resolved peaks was observed at 77°K. The magnitude and sign of the quadrupole splitting as a function of composition indicated a continuous change in the spin direction from along the c-axis to within the basal plane, consistent with the neutron diffraction cone model. The composition $x = 0.015$ was carefully studied at various temperatures. The temperature dependence of the hyperfine field did not follow a Brillouin function, but instead was almost linear, rather similar to the temperature dependence of the moment of $x = 0.15$ observed in the neutron study. There was also a significant increase in the quadrupole splitting as the temperature was lowered, which could indicate a decrease in the cone angle. (auth)

4902 (CONF-303-8) THE MÖSSBAUER SHIFT OF FERROUS PHENANTHROLINE AND RELATED COMPLEXES. Scientific Paper 63-927-115-P2. L. M. Epstein (Westinghouse Electric Corp. Research Labs., Pittsburgh). July 18, 1963. Contract [AT(30-2)-222]. 20p.

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

The center shifts at liquid nitrogen temperature of a number of substituted phenanthroline complexes, although they fell in a rather narrow range from about 0.50 to 0.53 mm/sec, showed a trend to larger values for the more electron withdrawing substituents and vice versa. Among the other ferroin-type complexes, the two with non-aromatic

ligands had appreciably larger center shifts than the aromatics. The non-bridged aromatic ligands all gave smaller center shifts than the phenanthrolines, suggesting greater covalency. In most cases the temperature dependence of the center shift was anomalously small, and several possible causes of this are suggested. (auth)

4903 (EURAEC-111) QUARTERLY REPORT NO. 3, JANUARY 1–MARCH 30, 1961 [ON ANALYTICAL CHEMISTRY]. (Brussels. Université). Work Performed under United States–Euratom Joint Research and Development Program. Contract 018.60.7 RDB. 22p.

Design and development of the galvanostatic equipment and its auxiliary units are described. Circuit diagrams are presented for the control unit, feed unit, galvanostatic polarization unit, potentiometric substractor, 50 kcs generator, controlling unit, and selector unit. (N.W.R.)

4904 (IS-626) THE INFERENCE OF ADSORPTION FROM DIFFERENTIAL DOUBLE LAYER CAPACITANCE MEASUREMENTS. II. DEPENDENCE OF SURFACE CHARGE DENSITY ON ORGANIC NON-ELECTROLYTE SURFACE EXCESS. Robert S. Hansen, Dennis J. Kelsh, and D. H. Grantham (Ames Lab., Ames, Iowa). [Feb. 14, 1963]. Contract W-7405-eng-82. 46p.

Dependences of boundary tension and capacitance at the mercury-aqueous 0.1N $HClO_4$ interface on polarization and organic solute concentration were determined for the solutes n-amyl alcohol and phenol. The surface charge density at fixed polarization varied linearly with surface excess in the case of n-amyl alcohol, but contained both linear and cubic terms in surface excess in the case of phenol suggesting a change in phenol orientation with increasing coverage. Near the electrocapillary maximum, the differential capacitance varied linearly with coverage in both cases. The theory of inference of adsorption from capacitance measurements is further discussed. It is pointed out that the "thermodynamic" inference based on double integration of non-static capacitance curves introduces (by integrating across desorption peaks) serious errors where solutes are strongly adsorbed at small concentrations. Criteria for estimating the errors thus introduced are suggested. An earlier treatment based on a (non-thermodynamic) assumption of linear variation of surface charge density with coverage appears adequately justified for inference of fractional surface coverages near the electrocapillary maximum, but must be considered approximate for evaluation of molar areas at full coverage in cases where linear variation of charge with coverage has not been demonstrated. (auth)

4905 (IS-683) CONVERSION OF X-RAY POWDER PATTERN MEASUREMENTS TO REFINED d-SPACINGS AND $1/d^2$; COMPUTER PROGRAM. O. D. McMasters and W. L. Larsen (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 43p.

The preliminary calculations for the indexing of x-ray diffraction powder patterns are coded for use on an IBM 7074 computer. The diffraction line position measurements obtained from powder patterns are converted to d-spacings that are corrected for errors due to absorption of x-rays by the specimen. The d-spacings are then refined on the basis of higher order reflection data and converted to $Q\ (= 1/d^2)$ values. The programs OSAGE and AUGMNT which perform these operations are described; and their FORTRAN listings are given. (auth)

4906 (LADC-5715) EFFECT OF SPECIFIC SURFACE ON THE SHOCK SENSITIVITY OF PRESSED GRANULAR PETN. Robert H. Dinegar, Richard H. Rochester and Mike S. Millican (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 8p.

The specific surface of pentaerythritoltetranitrate (PETN) was measured by a permeameter, an instrument that determines the surface per unit mass from air permeability measurements. Two different methods for obtaining the PETN with the desired specific surfaces were used. The first involved ball-milling the largest sized material for various periods of time to reduce the average size while the second consisted of precipitating the PETN from acetone by the addition of water under different conditions to obtain individual samples with the different specific surfaces. The results indicated that some other mechanism other than a surface burning reaction must determine the shock initiation to detonation in granular pressings of PETN. (P.C.H.)

4907 (LADC-5727) HISTORY OF BERYLLIUM POISONING. Thomas L. Shipman (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 8p.

A history of the discovery of Be poisoning is presented. A brief review of the symptoms of the disease is included. (C.H.)

4908 (NP-13324) LITERATURHINWEISE ZU RECHTS- UND WIRTSCHAFTS-FRAGEN DER ATOMENERGIE DER RAKETENTECHNIK DER WELTRAUMFAHRT. (Literature References on Legal and Economic Questions of Atomic Energy, Rocket Technology, and Space Travel). (Kernforschungsanlage, Julich, Germany). Sept. 1963. 53p.

Over 300 references on legal and economic aspects of atomic energy, rocket technology, and space travel are given. (M.C.G.)

4909 (NYO-10598) STRESSES AT NOZZLE CONNECTIONS OF PRESSURE VESSELS. Final Draft Report, October 1, 1962 to September 30, 1963. Donald E. Hardenbergh and Sam Y. Zamrik (Pennsylvania State Univ., University Park). Nov. 15, 1963. Contract AT(30-1)-1874. 35p.

The effects of externally applied loads upon cylinder-to-cylinder junctures in the range d/D from 0.60 to 1.00 were measured. Stresses resulting from a bending couple in the longitudinal plane, a bending couple in the transverse plane, and a thrust along the axis of the branch pipes were measured separately. The effect of internal pressure was studied independently of the effects of external loadings. (auth)

4910 (SC-DC-2049) TECHNIQUES FOR ANALYZING NONSTATIONARY VIBRATION DATA. P. T. Schoenemann (Sandia Corp. Livermore Lab., Livermore, Calif.). Nov. 1, 1963. Contract [AT(29-1)-789]. 12p.

From 33rd Symposium on Shock, Vibration and Associated Environments, Washington, D. C., Dec. 1963.

Methods are described and discussed, from a general viewpoint, for analyzing data on non-stationary vibrations. The analysis must take into account both frequency and time as variables, so the methods used are complex and voluminous. The case is also considered in which the vibrations are non-stationary but repetitive. The application of the methods discussed in analysis of missile-vibration problems is outlined. (T.F.H.)

4911 (SC-TM-172A-62(73)) SHOCK-TESTING METHODS. R. O. Brooks (Sandia Lab., Albuquerque, N. Mex.). Sept. 1963. Contract AT(29-1)-789. 71p.

A discussion is given of various problems and conditions that occur in mechanical shock testing in the areas of inadequate test specifications, shaping of shock pulses, in-

strumentation, and shock-pulse interpretation. Techniques which can be utilized to alleviate these problems are also discussed. (auth)

4912 (SC-TM-259-63(14)) A FUSED QUARTZ MICROBALANCE STUDY. R. F. Drury (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 15p.

A detailed study was conducted of a quartz microbalance which is used in ultra-high vacuum applications to make weight measurements of evaporated metal films to determine their gas sorption characteristics. It is basically a beam-type microbalance and is built entirely of fused quartz. The unique features of this balance are its application to high vacuum and its electrical readout capability. Magnetic damping allows the weighing to be performed rapidly. Ruggedness, ease of operation, accuracy, and sensitivity make the balance reliable. It can be operated easily within a five-inch diameter bell jar. (auth)

4913 (SC-TM-294-63(24)) DESIGN OF THE SAMPLING AND STRETCHING CIRCUITRY FOR A MULTIPLE APPLICATION PULSE FORM DIGITIZER. J. R. Rowland (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 29p.

Circuitry is designed for obtaining voltage samples of 10 to 15 nanoseconds duration from a 1 microsecond input pulse. A voltage which is proportional to the average value of the sampled voltage is first stored in a capacitor, then stretched to a width of 10 milliseconds, and finally amplified to be stored in a multiple aperture magnetic device. (auth)

4914 (TID-4043) INDEX TO CONFERENCES ABSTRACTED IN NUCLEAR SCIENCE ABSTRACTS. Willie E. Clark, Alden G. Green, and Margaret L. Pflueger, eds. (Division of Technical Information Extension, AEC). Dec. 1963. 67p.

Indexes were prepared to provide additional access to the conferences whose proceedings were abstracted in NSA Volumes 11 to 16, 1957 to 1962. The indexes are of the computer-made "Key Word in Context" kind and consist of the following parts: permuted titles and cities, dates, numbered conferences, report number, and title list. (D.L.C.)

4915 (TID-7683(p.16-20)) Pu AND ALL THAT. James L. Cate (Chicago. Univ.).

An informal discussion is presented of the historical program of USAEC. The problems in setting up such a program are considered. In April 1957, a small historical office was established by USAEC, followed by an advisory committee. The problems in writing official, contemporary history and some of the results of the historical office are discussed in some detail. (D.L.C.)

4916 (TID-18377) A NEW SPONTANEOUS HAMSTER CARCINOMA ASSOCIATED WITH A POSITIVE ERYTHROAGGLUTINATION REACTION AND ANEMIA. Joseph D. Sherman, Perry G. Rigby, Raymond L. Hackett, and Gilbert H. Friedell (Boston Univ. School of Medicine and New England Deaconess Hospital. Cancer Research Inst., Boston). Mar. 29, 1963. Contract AT(30-1)-901. 17p.

The appearance of a spontaneous carcinoma in an untreated male, golden hamster provided a very useful additional experimental model with which to study the anemia of malignancy. The tumor, of probably salivary gland origin, has been serially transplanted in the cheek pouch or flank of normal hamsters through 70 transplant generations. The growth characteristics are stable and predictable and a growth curve has been established. Growth of the tumor is associated with the development of a normochromic, normocytic anemia much like that seen in many human cancer patients. The anemia is not related to blood loss, metastases, cachexia or infection. The animals develop a positive erythroagglutination reaction (EAR) and red cell survival is shortened. The erythrocytes are not intrinsically defective, but an extrinsic destructive mechanism is operative. (auth)

4917 (TID-18382) FURTHER STUDIES ON THE PROPERTIES OF THE ASPERGILLUS TOXINS. E. B. Tilden, S. Freeman, and L. Lombard (Chicago Zoological Park, Animal Hospital, Brookfield, Ill.; Northwestern Univ., Chicago. Medical School; and Argonne National Lab., Ill.). Dec. 1962. Contract W-31-109-eng-38. 29p. (UAC-7178)

The nephrotoxin of Aspergillus flavus was tested for its effects in several animals for comparison with the toxin of Aspergillus fumigatus. For dogs, rats, and monkeys the flavus toxin was found to be less potent. Rabbits, however, were killed by doses comparable to those of fumigatus toxin. Increases in nonprotein nitrogen in the blood served as the measure of the nephrotoxic action. The azotemia in rats induced by fumigatus toxin was greater than that caused by nephrectomy and was greater for females than for males; the azotemia induced by flavus toxin was much less striking, though not negligible. The tissues of animals dying within 10 days as a result of the intravenous injection of flavus toxin showed histologic changes very similar to those induced by fumigatus toxin. The lesions were those of nephrosis with necrosis of a part or all of the proximal convoluted tubular epithelium, pulmonary hemorrhage and edema, chronic passive congestion with fatty change of the liver, necrotic foci in the spleen and heart, hemorrhages and focal areas of cellular exudate in several visceral organs. Variations in extent and severity of renal lesions occurred but were not correlated with the type of toxin injected. The flavus toxin was inactivated at a lower temperature (55° for 60 minutes) than the fumigatus toxin (65° for 60 minutes). The difference in resistance to heating of the hemolytic and toxic components of fumigatus toxin was confirmed. The effect of changes in pH was not marked, the pH range being broad in both cases. Flavus toxin was inactivated in the extreme acid range (pH 3.3 to 4.1) and in the extreme alkaline range (pH 9.0 to 10.0), while the fumigatus toxin was active at pH 4.0 and showed full activity at pH 9.5. The hemolytic property of the fumigatus toxin remained practically constant through this pH range. Comparison by intradermal injection of the rabbit skin of purified preparations of fumigatus of similar toxic potency but widely different hemolytic activity indicated a possible association of dermonecrotic property with hemolytic potency. However, the toxic potency for mice and rabbits of flavus toxin, which has no hemolytic activity, was comparable to that of fumigatus toxin, though in rats, dogs, and monkeys it was considerably less potent. (auth)

4918 (TID-19727) THE THERMODYNAMIC PROPERTIES OF IONS IN AQUEOUS AND NON-AQUEOUS SOLUTIONS AT VARIOUS TEMPERATURES. Progress Report No. 2, November 1, 1962–October 31, 1963. Cecil M. Criss (Vermont. Univ. and State Agriculture Coll., Burlington). Contract AT(30-1)-3019. 33p.

Results in every phase of studies on thermodynamic properties of ions in non-aqueous solvents are reported. Standard heats of solution of KCl in anhydrous methanol were accurately determined at 25 and 45°C, and the results were

combined with heat capacity data on crystalline KCl to give an average $C\bar{p}_2^0$ of −20 cal/deg-mole for KCl in the same temperature range. A new calorimeter with a smaller capacity and different design was constructed and tested. It will be used to measure heats of solution of KCl in N-methylformamide. Preliminary standard potentials of the silver-silver chloride electrode in methanol were determined at 5° intervals from 25 to 45°C, and activity coefficients of HCl in this solvent evaluated up to a concentration of 0.08m. A new cell was constructed to study mercury amalgam electrodes in order to obtain activity coefficients of the alkali halides in anhydrous solvents. (auth)

4919 (TID-19729) ABOUT THE PENETRATION OF WATER INTO PLASTICALLY DEFORMED NaCl. A. T. Kellogg and R. O. Pohl (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Nov. 1963. Contract [AT(30-1)-2179]. 11p.

Rock salt pieces show a considerable increase in plasticity after immersion in water. This effect has been attributed either to a surface effect (Joffé) or to diffusion of water into the bulk of the crystal (Smekal). Experiments were made in which the infrared absorption spectra of artificial NaCl and KBr single crystals were measured before and after immersion in water. No water could be detected unless the crystals were previously crushed or cleaved to form large cracks. It is concluded that water can enter the crystal only through large cracks, and that Joffé's model is more probable than Smekal's model. (D.L.C.)

4920 (TID-19731) A STUDY OF THE MECHANISM OF STRESS-CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report No. 1, July 17, 1963–October 16, 1963. F. H. Beck, M. G. Fontana, and J. P. Hirth (Ohio State Univ. Research Foundation, Columbus). Oct. 4, 1963. Contract AT(11-1)-1319. 15p.

A research program is being conducted to investigate the properties of Fe–Cr–Ni alloys as related to their susceptibility to stress corrosion cracking by chloride and hydroxide solutions. The studies will include stress corrosion cracking experiments, physical metallurgy studies, and electrochemical experiments. The accomplishments to date are described briefly. (D.L.C.)

4921 (TID-19734) SLOPE MOVEMENT AND MICRO-ENVIRONMENT AT CAPE THOMPSON, ALASKA. Report No. 1. Final Report, March 15, 1962–September 15, 1963. Kaye R. Everett (Ohio State Univ., Columbus. Inst. of Polar Studies). Oct. 31, 1963. Contract AT(11-1)-1157. 5p.

Results are reported from quantitative measurements of slope movement and the micro-environment at Cape Thompson, Alaska. The effects of freeze-thaw cycles on the rate, time, and kind of movements occurring on the valley slopes was studied. (C.H.)

4922 (TID-19738) VAPORIZATION BEHAVIOR AND PHOSPHORUS DECOMPOSITION PRESSURES OF TUNGSTEN MONOPHOSPHIDE. K. A. Gingerich (Pennsylvania State Univ., University Park). [1963]. Contract AT (30-1)-2541. 15p.

The vaporization of tungsten monophosphide, WP, was studied by Knudsen effusion techniques in combination with a mass spectrometer. The major vapor species was P_2 with a small amount of P_4. No tungsten-containing species was observed. At 1000°C, WP vaporizes by decomposition into gaseous phosphorus and tungsten metal saturated with phosphorus. No range of homogeneity was observed for WP. An average molal enthalpy of decomposition, $\Delta H_{1100°K}$, of 75.66 ± 1.06 kcal per mole of P_2 (g) was obtained from a second law treatment for the composition range $WP_{0.96}$–$WP_{0.65}$, where the uncertainty represents the standard deviation. The temperature dependence of the P_2-decomposition pressure was found to be linear over the temperature range from 950 to 1250°K and can be expressed by the equation $\log p_{atm}[P_2] = (-16534/T) + 8.501 \pm 0.111$. (auth)

4923 (TID-19773) VEMA FRACTURE ZONE: EQUATORIAL ATLANTIC. Bruce C. Heezen, Robert Gerard, and Marie Tharp (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Oct. 1963. Contract AT(30-1)-2663. 16p.

A series of fracture zones displaces the axis of the Mid-Atlantic Ridge in the equatorial Atlantic. Near 11°N latitude the crest of the ridge is offset about 150 miles to the left by the Vema Fracture Zone. The Demerara Abyssal Plain extends into the fracture zone from the west. A low oceanographic sill is provided by the fracture zone. Bottom photographs and cores indicate strong bottom scour through the trough in depths exceeding 5000 meters. (auth)

4924 (TID-19779) ANNUAL PROGRESS REPORT ON WORK IN VERTICAL AND LATERAL MOVEMENTS OF WATER IN THE OCEANS AND THEIR PREDICTION. Irving I. Schell (Tufts Univ., Medford, Mass.). Sept. 30, 1963. Contract AT(30-1)-2929. 11p.

Results are reported from an analysis of the mean monthly March 1956 to March 1957 winds in the eastern South Pacific, adjacent mainland, and the corresponding mean monthly sea surface temperatures along the west coast of South America; an analysis of the airflow in March 1956 and March 1957 in relation to the sub-surface temperature and oxygen content values at approximately the same location off-shore of Chile; an analysis of the mean monthly vertical temperature distribution at selected stations in the northeastern North Atlantic during both summer and winter months in relation to the mean monthly wind strength and air temperature; and an analysis of the sub-surface off Bermuda in relation to the mean monthly wind strength in that general area. (C.H.)

4925 (UR-633) THE FUNCTIONAL SIGNIFICANCE OF SULFHYDRYL GROUPS IN THE CELL MEMBRANE. Aser Rothstein and Robert I. Weed (Rochester, N. Y. Univ. Atomic Energy Project). Oct. 16, 1963. Contract W-7405-eng-49. 37p.

Evaluation of the functional significance of sulfhydryl groups in the cell membrane depends in part on certain unpredictable properties of protein sulfhydryl groups. These include problems of specificity related to sulfhydryl reacting reagents used to determine sulfhydryl content, relative reactivity of the sulfhydryl groups themselves, and existence of functionally unresponsive sulfhydryl groups along with those essential for the physiological activity under study. In studies of membranes, problems of distribution and permeation of the sulfhydryl reagents provide additional complications. For example, studies of the human red cell membrane or ghost have permitted classification of the membrane sulfhydryl groups on the basis of their activity with various reagents. Approximately 7% of the membrane groups are readily reactive and react with N-ethylmaleimide, chlormerodrin, and $HgCl_2$, but this reaction does not inhibit membrane ATPase, or Na^+ or K^+ permeability. Additional partially reactive sulfhydryl groups (up to 25% of the total) will react with chlormerodrin and $HgCl_2$, and this reaction results in inhibition of ATPase activity, inhibition of glucose uptake and some loss of K^+. Finally, the masked groups constituting the remaining 75% of the membrane sulfhydryl groups, react only with $HgCl_2$

to produce Na^+ permeability, tanning of the membrane, and denaturation of protein. (auth)

4926 (WAPD-T-1559) INTERPRETIVE REPORT OF PRESSURE VESSEL RESEARCH. Section 1.6 Ligaments and Perforated Plates. B. F. Langer (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1963. Contract AT(11-1)-Gen-14. 23p.

In order to use perforated plates with confidence, a designer needs better stress analysis methods. The Pressure Vessel Research Committee established a Subcommittee on Stresses in Ligaments to develop such methods. Studies were made on flat circular plates with triangular and rectangular hole patterns, and the results are given. Work has been started on curved plates (shells and heads). (D.L.C.)

4927 (AEC-tr-6158) NUCLEUS FORMATION DURING SEGREGATION IN METALLIC SOLID SOLUTIONS. R. Becker. Translated for Oak Ridge National Lab., Tenn., from Ann. Physik, 32: 128-40(1938). 19p.

With the assumption that it is permissible to calculate the energy of a solid solution by the simple addition of adjacent bonds, the nucleus formation work for the segregation in a supersaturated binary solid solution is calculated. The frequency of the nucleus formation can be calculated from the above. A satisfactory agreement with existing measurements on the rate of segregation results from the calculation of a numerical example for those supersaturations in which the nucleus formation frequency has attained its maximum. (auth)

4928 (AEC-tr-6160) MECHANISM OF ACTION AND PROPERTIES OF THE MYELOID LEUKEMIA VIRUS ACTIVE IN MICE AND RATS. A. Graffi. Translated for Oak Ridge National Lab., Tenn., from Acta. Unio Intern. Contra Cancrum, 17: 181-97(1961). 33p.

Additional results are presented concerning the characterization of the myeloid leukemia virus in the mouse. The effectiveness of various forms of application, including the vertical intrauterine transfer, is described. The inhibiting effect of splenectomy on the virus action is eliminated again by injection of spleen extracts. The virus also produces myeloid and to a lesser degree lymphatic and reticular leukoses in the rat. The immunological properties of the virus are described, with the use of inactivation tests as well as saturation tests with normal and leukemic tissue and cross-reactions between mouse and rat virus. Biochemically the virus can be characterized as a lipoid-nucleoproteid complex. Some positive transfer results could be obtained with isolated RNA. In an ultrathin section under the electron microscope, the virus could be found predominantly in extracellular form and more rarely in the cytoplasm of the cell in the form of round particles of 70–150 mμ in the sections of diseased lymph nodes. It has a fine structure in the form of one or several enveloping membranes and one nucleoid. Four different formative elements could be distinguished on the basis of the fine structure. Experiments to grow the virus with a culture solution of leukemia tissue grown in vitro lead to clearly positive results. In the inoculation of trypsinized embryo cultures of mice with leukemia tissue, a transmissible cytopathogenic effect (CPE) occurred in cell-free transfers. The cell-free nutrient solution of such cultures exhibited a highly oncogenic action in the rat, hamster, and mouse. Exclusively mesenchymal tumors occurred in more than 50% of the animals, primarily bone, kidney, and skin sarcomas as well as lipomas and liposarcomas. The absence of the hemagglutination effect, the higher heat instability in animal tests and the somewhat different tumor spectrum (large number of lipomas and liposarcomas) compared with the parotid tumor of Gross, Stewart, and Eddy indicates that there is no complete correspondence between the latter and this agent. (auth)

4929 (AEC-tr-6161) STUDIES REGARDING THE POSSIBILITY OF GROWING THE VIRUS OF MYELOID LEUKEMIA OF THE MOUSE IN A TISSUE CULTURE. A. Graffi, L. Baumbach, T. Schramm, and D. Bierwolf. Translated for Oak Ridge National Lab., Tenn., from Z. Krebsforsch., 65: 385-95(1963). 19p.

It is apparent from the highly leukemogenic action of the cell-free culture medium that the cells of virus-caused myeloid mouse leukemia produce active virus for several weeks in the tissue culture, even after several replacements of the culture medium. New virus formation takes place also for several weeks in cultures of trypsinized normal mouse embryo tissue after inoculation with cell-free filtrate from myeloid mouse leukemias. By electron microscopy it was confirmed that the reproduction of the virus particles takes place predominantly at the outer membrane of the leukemia cells by a budding and segmentation process. (auth)

4930 (AEC-tr-6167) INITIAL SINTERING OF TUNGSTEN. RELATION BETWEEN LINEAR SHRINKAGE AND PARTICLE SIZE, SINTERING TEMPERATURE AND TIME. Teruhiko Yao. Translated for Los Alamos Scientific Lab., N. Mex., from Funtai Oyobi Funmatsuyakin, 9: 217-21 (1962). 9p.

The initial sintering process of tungsten powder compacts was studied. The compacts consist of various mixtures of coarse, medium, and fine powders. The dependences of linear shrinkage upon particle size, sintering time, etc. are in good agreement with the model of "bulk diffusion" proposed by Kingery, Berg, and Coble. Especially, the shrinkage of the ternary mixture compacts is well explained by the model; however, the shrinkage of coarser powder compacts whose mixing ratios of coarse/fine are greater than $^1/_3$ is in less good agreement. The activation energy for the sintering process is about 86,000 cal mol^{-1}. (auth)

4931 (AEC-tr-6168) SINTERING OF TUNGSTEN METAL POWDER. Teruhiko Yao and Yukio Anekoji. Translated for Los Alamos Scientific Lab., N. Mex., from Funtai Oyobi Funmatsuyakin, 9: 163-8(1962). 11p.

The influence of particle size distribution, specific surface area, mixing ratio of fine and coarse powder, and compacting pressure on the rate of sintering of tungsten metal powder was studied. It was found that the rate of sintering $\delta_1-\delta_0/\delta_t-\delta_0$ (δ_0 = green density, δ_1 = sintered density, δ_t = true density) is proportional to the specific area and is affected by particle size distribution of powder having the same average particle size, but not affected by packing density. The effect of compacting pressure upon the rate of sintering was not found and the densification rate decreased with increasing compacting pressure. (auth)

4932 (AEC-tr-6176) ON THE MECHANISM OF THE DEATH OF BACTERIA BY LOW-TEMPERATURE TREATMENT. Toru Sato. Translated for Oak Ridge National Lab., Tenn.), from Teion Kagaku, B, 12: 39-61(1954). 56p. (Includes Original, 23p.).

E. coli suspensions were treated under various cooling conditions, and the number of surviving cells was measured. Results are summarized. (C.H.)

4933 (AEC-tr-6179) WAVE FLOW OF THIN LAYERS OF A VISCOUS LIQUID. PART 2. FLOW AT CON-

TACT WITH A GAS STREAM, AND HEAT TRANSFER. P. L. Kapitsa. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Eksperim. i Teor. Fiz., No. 1, 19-28(1948). 13p.

The problem of the interaction between a gas stream and a liquid flow has been studied. It has been shown that by assuming breakdown conditions in the gas stream during its flow around the wave surface of the liquid, it is possible to explain and calculate quantitatively the increase in the pressure drop in the gas stream that flows through tubes with wet walls. An expression is derived for the critical velocity at which "chocking" occurs in the vertical tube where the liquid flows countercurrently to the gas down the walls. This expression shows agreement with the experimental data. An estimate of the increased heat transfer in thin liquid layers at the wave state (regime) is given. (auth)

4934 (HW-tr-60) METHOD OF PREPARING TRITIATED BENZENE FOR SCINTILLATION MEASUREMENT OF LOW-LEVEL TRITIUM CONTENTS IN HYDROLOGY. L. Pichat, D. Sharefkin, and M. Herbert [France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay]. Translated by E. R. Appleby (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.), from report CEA-2234. 1962. 13p.

A method is needed to increase the sensitivity of counting of tritiated water by a factor of 5 to 10. A simple, rapid method for the preparation of tritiated benzene from the tritiated water was developed, based on the decarboxylation of calcium mellitate (benzene hexacarboxylate) in the presence of lime. The necessary lime is prepared by reacting CaO with the tritiated water. For the decarboxylation, an excess of lime (2 moles lime for each 0.2 mole calcium mellitate) is required for good benzene yields. It is not known if there is an isotope effect in the reaction. The resulting tritiated benzene can be used as a solute in a scintillating liquid for counting. (D.L.C.)

4935 (SC-T-524) THE BAUSCHINGER EFFECT AND ITS PRACTICAL APPLICATIONS. W. Spaeth. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Metall., 8: No. 1/2, 25-9(1954). 15p.

The application of a stress on a metal in one direction results in an increase in its strength (cold work hardening), but this effect can be offset by applying another stress in the opposite direction (cold work softening). This second effect, first demonstrated by Bauschinger, frequently results in a decreased strength. A model of parallel rods or fibers is used to examine the emergence of the Bauschinger effect and the consequences of dislocation creeps under a constant deformation. The applications of this effect in fabrication processes are discussed. (D.L.C.)

4936 LONG-TERM ECONOMY OF NUCLEAR ENERGY. R. Gibrat. Energie Nucl., 5: 397-405(Sept.-Oct. 1963). (In French)

The production of energy by breeder reactors is examined from a long-range viewpoint. Costs and financial aspects are ignored in deference to political and conservation aspects. The nuclear characteristics that could affect long-range programming are discussed. (T.F.H.)

4937 OPTIMIZING PERSONNEL UTILIZATION AND ADVANCEMENT WITH ANOMALOUS EMPLOYEE PRACTICES AND PROCEDURES. Bruce W. Link (Ames Lab., Ames, Iowa). 7p. (CONF-243-13)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The supply of potential employees with reactor experience appears to be more than adequate. Reactor-oriented personnel who have both the ability and the determination to continue their education are not so plentiful. The Ames Laboratory Personnel Office and Reactor Division employees are willing to accept the time and effort required to seek out the type of person who can and will take advantage of the opportunity of combining employment with education to the extent described. (auth)

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ö		oe
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14	18-4881	ORINS. Gmelin, AED-CONF-63-168-6
15	18-4882	ORINS. Gmelin, AED-CONF-63-168-10
16	18-4703	ORINS. Gmelin, AED-CONF-63-168-12
17	18-4883	ORINS. Gmelin, AED-CONF-63-168-15
19	18-4830	See HW-SA-3095

Report No.	Abstract No.	Availability
20	18-4847	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-7
21	18-4690	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-29
24	18-4691	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-27
25	18-4789	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-28
26	18-4822	ORINS. Gmelin, AED-CONF-63-168-18
27	18-4824	ORINS. Gmelin, AED-CONF-243-27
28	18-4823	ORINS. Gmelin, AED-CONF-63-168-23
29	18-4767	ORINS. Gmelin, AED-CONF-63-168-24
30	18-4852	See UCRL-7335
31	18-4853	See UCRL-7353
32	18-4821	ORINS. Gmelin, AED-CONF-63-168-36
33	18-4880	ORINS. Gmelin, AED-CONF-63-168-34
CONF-250–	**(American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., August 1963)**	
9	18-4129	ORINS. Gmelin, AED-CONF-63-131-13
13	18-4511	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-131-14
CONF-281–	**(International Conference on Beryllium Oxides, Sydney, October 1963)**	
4	18-4300	See GA-4643
CONF-285–	**(7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., October 1963)**	
4	18-4527	$2.60(fs), $0.83(mf) OTS
6	18-3705	ORINS. Gmelin, AED-CONF-63-149-4
CONF-294–	**(Canadian Federation of Biological Societies 6th Annual Meeting, London, Ont., Canada, June 1963)**	
1	18-3582	ORINS. Gmelin, AED-CONF-63-145-1
CONF-297–	**(International Conference and Exhibit on Aerospace Support, Washington, D. C., August 1963)**	
2	18-4845	ORINS. Gmelin, AED-CONF-63-142-2
3	18-4844	ORINS. Gmelin, AED-CONF-63-142-1
CONF-301–	**(International Conference on the Science of Superconductivity, Hamilton, New York, August 1963)**	
1	18-4506	ORINS. Gmelin, AED-CONF-63-148-1
8	18-4503	ORINS. Gmelin, AED-CONF-63-148-8
9	18-4502	ORINS. Gmelin, AED-CONF-63-148-9
16	18-4505	ORINS. Gmelin, AED-CONF-63-147-2
17	18-4510	ORINS. Gmelin, AED-CONF-63-147-3
18	18-4509	ORINS. Gmelin, AED-CONF-63-148-12
20	18-4504	ORINS. Gmelin, AED-CONF-63-148-14
21	18-4508	ORINS. Gmelin, AED-CONF-63-148-15
CONF-303–	**(3rd International Conference on the Mössbauer Effect, Ithaca, New York, September 1963)**	
6	18-4901	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-143-11
7	18-4357	ORINS. Gmelin, AED-CONF-63-143-7
8	18-4902	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-143-13
9	18-4528	Dep.(mc); $2.60(fs), $0.86(mf) OTS; Gmelin, AED-CONF-63-143-12
11	18-4355	ORINS. Gmelin, AED-CONF-63-143-4
CONF-308–	**(American Institute of Aeronautics Meeting on Engineering Problems on Manned Interplanetary Exploration, Palo Alto, Calif., September 1963)**	
1	18-4843	ORINS. Gmelin, AED-CONF-63-154-1
CONF-310–	**(Symposium on Physics and Nondestructive Testing, San Antonio, October 1963)**	
1	18-4130	ORINS. Gmelin, AED-CONF-63-150-1
CONF-311–	**(American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, New Mex., October 1963)**	
2	18-4842	ORINS. Gmelin, AED-CONF-63-163-3
6	18-4836	See SC-DC-3249
7	18-4768	ORINS. Gmelin, AED-CONF-63-163-8
CONF-315–	**(Norton Company's Symposium on the Technology of Powder Filled UO_2 Fuel Elements, Worchester, Mass., November 1963)**	
1	18-4299	Dep.(mc); $2.60(fs), $1.04(mf) OTS
CONF-318–	**(The Society of Naval Architects and Marine Engineers Annual Meeting, New York, N. Y., November 1963)**	
2	18-4359	ORINS
CONF-319–	**(33rd Symposium on Shock, Vibration and Associated Environments, Washington, D. C., December 1963)**	
1	18-4910	See SC-DC-2049
CONF-320–	**(International Conference on Cosmic Rays, Jaipur, India, December 1963)**	
1	18-4413	See UCRL-7551
CONF-321–	**(Conference on Programming for H.P.D. and Other Flying Spot Devices, Paris, August 1963)**	
1	18-4082	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CONF-326–	**(7th National Convention on Military Electronics, Washington, D. C., September 1963)**	
1	18-4323	ORINS. Gmelin, AED-CONF-63-167-1
2	18-4048	ORINS. Gmelin, AED-CONF-63-167-2
CONF-327–	**(Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., October 1963)**	
1	18-4630	ORINS. Gmelin, AED-CONF-63-162-2
2	18-4632	ORINS. Gmelin, AED-CONF-63-162-1
3	18-4525	See BNL-7349
4	18-4529	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-162-8
5	18-4631	ORINS. Gmelin, AED-CONF-61-162-9
6	18-4629	ORINS. Gmelin, AED-CONF-63-162-10
CONF-329–	**(Southeast Regional Conference of the National Association of Corrosion Engineers, Miami, November 1963)**	
1	18-4194	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CONF-332–	**(Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., November 1963)**	
2	18-4742	See LADC-5845
CONF-334–	**(Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., October 1963)**	
1	18-4799	See LADC-5825
2	18-4752	ORINS. Gmelin, AED-CONF-63-171-3
3	18-4293	ORINS. Gmelin, AED-CONF-63-171-4
4	18-4790	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-171-2
CONF-337–	**(International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, November 1963)**	
1	18-4018	See HW-SA-3210
2	18-4017	See HW-SA-3176
CONF-338–	**(Soil Science Society of America, Denver, Colo., November 1963)**	
1	18-4007	See DPSPU-63-30-29
CONF-341–	**(4th Electric Initiator Symposium, Philadelphia, October 1963)**	

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1	18-4327	See LADC-5862
CONF-346–		**(International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., October 1963)**
1	18-4154	See BNL-7396
CONF-350–		**(European Conference on Vacuum, Frankfurt, Germany, June 1963)**
1	18-4054	See MATT-212
CONF-351–		**(Centennial of the National Academy of Sciences, Washington, D. C., October 1963)**
1	18-4434	See UCRL-11076
CONF-356–		**(1963 American Society of Metals/Metals and Materials Show, Cleveland, October 1963)**
1	18-4240	Dep.(mc); $2.60(fs), $0.83(mf) OTS; Gmelin, AED-CONF-63-197-1
CONF-363–		**(International Symposium on Plasma Phenomena, San Diego, Calif., October 1963)**
1	18-4060	See UCRL-7419
CDO–		
228	18-3480	Dep.(mc); $13.00(fs), $5.66(mf) OTS
228(p.143-68)	18-3490	Radiation Res., 20: 549-63(1963)
CVNA–	**(Misc.)**	
143	18-4791	Dep.(mc); $1.10(fs), $0.80(mf) OTS
D–	**(Misc.)**	
1-82-0302	18-4396	
DEP/SEPP–	**(French)**	
211-62	18-4804	For translation see AEC-tr-6155
DLCS–		
5001063	18-4792	Dep.(mc); $5.60(fs), $1.85(mf) OTS
DP–		
857	18-3952	Dep.; $1.00(OTS)
DPSPU–		
63-30-13	18-4083	Dep.(mc); $1.10(fs), $0.80(mf) OTS
63-30-29	18-4007	Dep.(mc); $1.60(fs), $0.80(mf) OTS
DRI–	**(Misc.)**	
2123	18-4241	Dep.(mc); $1.60(fs), $0.80(mf) OTS
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EANDC–	**(European-American Nuclear Data Committee)**	
33U	18-4084	Dep.(mc)
EANDC(OR)–	**(European-American Nuclear Data Committee)**	
26U	18-4848	Dep.(mc)
EANDC(UK)–	**(European-American Nuclear Data Committee)**	
26U	18-4538	Dep.(mc)
ETR–	**(Belgian)**	
138	18-3879	See NP-13287
140	18-4888	See NP-13289
143	18-3880	See NP-13290
EUR–	**(European Atomic Energy Community)**	
307.e	18-3673	Dep.(mc)
401.e	18-4741	Dep.(mc)
402.i	18-4242	Dep.(mc)
475.i	18-4051	Dep.(mc)
EURAEC–		
92	18-4209	See ATL-423
111	18-4903	Dep.(mc); $2.60(fs), $0.86(mf) OTS
181	18-3953	Dep.(mc); $2.60(fs), $0.89(mf) OTS
613	18-4243	Dep.(mc); $9.10(fs), $3.23(mf) OTS
803(Pt.III)	18-4801	See NYO-9992
804	18-4198	See NMI-1911
865	18-4241	See DRI-2123
870	18-4301	See GEAP-4325
886	18-4762	See GEAP-4385
892	18-4692	Dep.(mc); $5.60(fs), $1.76(mf) OTS
893	18-4196	See GEAP-4393
FN-E–	**(Italian)**	
8	18-3953	See EURAEC-181
FTD-TT–	**(Non-AEC)**	
63-381	18-4331	OTS
63-579	18-4094	OTS
GA–	**(Misc.)**	
4292	18-4512	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-048-109
4599	18-4849	Dep.(mc); $1.10(fs), $0.80(mf) OTS
4638	18-4513	Dep.(mc); $2.60(fs), $1.01(mf) OTS
4643	18-4300	Dep.(mc); $6.60(fs), $2.24(mf) OTS
4693	18-4793	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GAMD–	**(Misc.)**	
4273	18-4794	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEAP–	**(Misc.)**	
3924	18-4795	Dep.; $4.00(OTS)
4153	18-4796	Dep.; $3.50(OTS)
4182	18-4195	Dep.(mc); $19.75(fs), $9.95(mf) OTS
4203	18-4797	Dep.(mc); $7.60(fs), $2.48(mf) OTS
4325	18-4301	Dep.(mc); $3.60(fs), $1.31(mf) OTS
4327	18-4798	Dep.(mc); $8.10(fs), $2.66(mf) OTS
4351	18-4161	Dep.(mc); $8.60(fs), $3.05(mf) OTS
4382	18-4760	Dep.(mc); $5.60(fs), $1.88(mf) OTS
4383	18-4761	Dep.(mc); $4.60(fs), $1.61(mf) OTS
4385	18-4762	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4393	18-4196	Dep.(mc); $2.60(fs), $0.86(mf) OTS
HMI-B–	**(German)**	
27	18-4763	Dep.(mc)
30	18-4155	
HNS–		
1229-22	18-3978	Dep.(mc); $2.60(fs), $0.98(mf) OTS
HW–		
68268	18-3876	Dep.(mc); $1.60(fs), $0.80(mf) OTS
68600-26	18-4162	Dep.(mc); $1.10(fs), $0.80(mf) OTS
68600-27	18-4163	Dep.; $0.50(OTS)
74093	18-3931	Dep.(mc); $11.00(fs), $4.49(mf) OTS
78651(Rev.)	18-3877	Dep.; $1.00(OTS)
79140	18-4886	Dep.; $1.00(OTS)
79143	18-4210	Dep.; $3.60(fs), $1.22(mf) OTS
HW-SA–		
2274(Rev.)	18-4302	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2406	18-4244	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2453	18-4164	Dep.(mc); $3.60(fs), $1.40(mf) OTS
2965	18-3709	Dep.(mc); $2.60(fs), $0.92(mf) OTS
3095	18-4830	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3176	18-4017	Dep.(mc); $2.60(fs), $0.92(mf) OTS
3210	18-4018	Dep.(mc); $3.60(fs), $1.28(mf) OTS
HW-tr–		
60	18-4934	Dep.(mc); $1.60(fs), $0.80(mf) JCL

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HWS–		
10000	18-3921	See TID-15244(Rev.)
10001	18-3922	See TID-15245(Rev.)
10003-1	18-3923	See TID-15246(Vol.I)(Rev.)
10003-2	18-3924	See TID-15246(Vol.II)(Rev.)
10004	18-4215	See TID-15247(Rev.)
10005	18-4059	See TID-19752
10006	18-3925	See TID-19753
10007	18-4026	See TID-19754
10007(Index)	18-3926	See TID-19755
IS–		
567	18-4165	Dep.; $1.25(OTS)
626	18-4904	Dep.(mc); $4.60(fs), $1.58(mf) OTS
660	18-3878	Dep.; $0.50(OTS)
677	18-3710	Dep.; $2.75(OTS)
683	18-4905	Dep.; $1.00(OTS)
JINR–	**(Russian)**	
E-1384	18-4539	Dep.(mc)
E-1400	18-4430	Dep.(mc)
P-1369	18-4540	Dep.(mc)
P-1385	18-4541	Dep.(mc)
P-1387	18-4090	Dep.(mc)
JLI–		
2901-0-1	18-3810	Dep.; $1.50(OTS)
JPRS–	**(Non-AEC)**	
21996	18-3502	$0.50(OTS)
21997	18-3455	$0.50(OTS)
22000	18-3584	$0.50(OTS)
22001	18-3503	$0.50(OTS)
22017	18-3504	$0.50(OTS)
22034	18-3456	$0.50(OTS)
22119	18-3633	$0.50(OTS)
22122	18-3505	$0.50(OTS)
22186	18-3440	$0.50(OTS)
JüL–	**(German)**	
96-RG	18-4808	Atomkernenergie, 5: 15-18; 100-7(1960)
KAPL–		
2290	18-3954	Dep.(mc); $10.10(fs), $3.95(mf) OTS
KFK–	**(German)**	
135	18-4542	Dep.(mc)
LA–		
2974	18-4326	Dep.; $0.75(OTS)
LADC–		
5356	18-4634	Dep.(mc); $2.60(fs), $1.01(mf) OTS
5715	18-4906	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5718	18-3711	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5723	18-4485	Dep.(mc); $6.60(fs), $2.12(mf) OTS
5727	18-4907	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5728	18-3712	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5740	18-3801	J. Chem. Phys., 39: 2581-7(1963)
5825	18-4799	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5845	18-4742	Dep.(mc); $4.60(fs), $1.46(mf) OTS
5862	18-4327	Dep.(mc); $4.60(fs), $1.64(mf) OTS
5865	18-3756	J. Chem. Phys., 39: 3001-9(1963)
LAL–	**(French)**	
1077	18-4431	Dep.(mc); Phys. Letters, 7: 215-16(1963)
LAMS–		
2427	18-4753	Dep.; $1.25(OTS)
2937	18-4887	Dep.; $1.00(OTS)
2959	18-4019	Dep.; $0.75(OTS)
2965	18-4245	Dep.; $0.50(OTS)
2966	18-4833	Dep.; $2.75(OTS)
LF–		
1	18-4061	Ann. Occupational Hyg., 6: 1-14(1963)
11	18-3438	Dep.; $0.75(OTS)
12	18-4052	Dep.; $0.50(OTS)
LNF–	**(Italian)**	
63/46	18-4362	Dep.(mc)
63/50	18-4053	Dep.(mc)
63/53	18-4363	Dep.(mc)
63/55	18-4364	Dep.(mc)
MATT–		
196	18-4635	Dep.; $2.50(OTS)
212	18-4054	Dep.(mc); $2.60(fs), $1.04(mf) OTS
MCW–		
1468	18-3674	Dep.; $0.50(OTS)
MLM–		
1171	18-4166	Dep.; $1.60(fs), $0.80(mf) OTS
MND-P–		
2977	18-4142	Dep.; $2.00(OTS)
MSAR–	**(Misc.)**	
63-156	18-4201	See TID-19756
63-161	18-4197	Dep.(mc); $7.60(fs), $2.60(mf) OTS
NAA-SR–		
7544	18-4167	Dep.; $1.25(OTS)
8621	18-4514	Dep.; $0.75(OTS)
8722	18-4800	Dep.; $2.75(OTS)
NAA-SR-Memo–		
2068	18-4020	Dep.(mc); $1.10(fs), $0.80(mf) OTS
8800	18-3920	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8943	18-3675	Dep.(mc); $2.60(fs), $0.89(mf) OTS
9168	18-4021	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NAS-NRC–	**(Non-AEC)**	
Pub-1092	18-3446	NAS
NASA-TT–	**(Non-AEC)**	
F-73	18-4332	$5.00(OTS)
NIRL-R–	**(British)**	
41	18-4091	Dep.(mc); $0.60(BIS); 3s. (HMSO)
45	18-4168	Dep.(mc); $0.70(BIS); 3s. 6d. (HMSO)
NLCO–		
891	18-4211	Dep.; $0.50(OTS)
NMI–	**(Misc.)**	
1911	18-4198	Dep.; $2.00(OTS)
NP–	**(AEC File No. for Non-AEC Reports)**	
13165(Vol.1)	18-4543	Dep.(mc)
13165(Vol.2)	18-4567	Dep.(mc)
13178	18-3452	
13287	18-3879	
13289	18-4888	
13290	18-3880	
13296	18-4636	
13297	18-4637	
13298	18-4638	
13312	18-4022	Dep.(mc)
13319	18-3955	
13320	18-3676	Dep.(mc)

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13321	18-4303	Dep.(mc)
13324	18-4908	Dep.(mc)
13327	18-4397	Dep.(mc)
13329	18-4398	Dep.(mc)
13330	18-4399	Dep.(mc)
13332	18-3813	Dep.(mc)
13340	18-4143	Dep.(mc)
13341	18-4400	Dep.(mc)
13342	18-4304	
13345	18-4365	Dep.(mc)
13352	18-4366	Dep.(mc)
13353	18-4367	Dep.(mc)
13361	18-4328	
13365	18-4639	Dep.(mc)
13370	18-4580	Dep.(mc); Proc. Phys. Soc. (London), 82: 1002-5(1963)
13371	18-4581	Dep.(mc)
13372	18-4055	Dep.(mc)
13378	18-4582	Dep.(mc)
13388	18-4023	Dep.(mc); $0.30(BIS); 1s. 9d. (HMSO)
13391	18-4024	Dep.(mc)
13393	18-4169	
13404	18-4056	
NP-tr-	**(AEC File No. for Non-AEC Translations)**	
1071	18-4373	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
NRL-	**(Misc.)**	
5981	18-4684	$3.60(OTS)
NSEC-		
85	18-3677	Dep.; $2.25(OTS)
NUS-		
144	18-4834	Dep.(mc); $9.10(fs), $3.50(fs) OTS
NYO-		
162-4	18-3932	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NYO-		
9992	18-4801	Dep.; $2.25(OTS)
10517	18-3979	Dep.(mc); $11.50(fs), $4.76(mf) OTS
10581	18-3447	Dep.(mc); $7.60(fs), $2.60(mf) OTS
10598	18-4909	Dep.(mc); $3.60(fs), $1.25(mf) OTS
ORA-	**(Misc.)**	
03424-9-T	18-3955	See NP-13319
ORNL-		
3470	18-4170	Dep.; $3.50(OTS)
3479	18-4025	Dep.; $2.00(OTS)
3500	18-4214	Dep.; $3.60(fs), $1.22(mf) OTS
3518	18-4889	Dep.; $1.00(OTS)
ORNL-TM-		
290	18-4850	Dep.(mc); $1.60(fs), $0.80(mf) OTS
332	18-4851	Dep.(mc); $2.60(fs), $0.98(mf) OTS
504	18-3881	Dep.(mc); $1.10(fs), $0.80(mf) OTS
688	18-3882	Dep.(mc); $1.60(fs), $0.80(mf) OTS
713	18-3975	Dep.(mc); $4.60(fs), $1.46(mf) OTS
717	18-3883	Dep.(mc); $2.60(fs), $0.86(mf) OTS
735	18-4828	Dep.(mc); $1.60(fs), $0.80(mf) OTS
OTS-	**(Misc.)**	
63-41211	18-3502	For translation see JPRS-21996
63-41212	18-3455	For translation see JPRS-21997
63-41215	18-3584	For translation see JPRS-22000
63-41216	18-3503	For translation see JPRS-22001
63-41226	18-3504	For translation see JPRS-22017
63-41234	18-3456	For translation see JPRS-22034
63-41277	18-3633	For translation see JPRS-22119
63-41280	18-3505	For translation see JPRS-22122
63-41316	18-3440	For translation see JPRS-22186
PAN-	**(Polish)**	
262	18-4583	Dep.(mc)
446/II.IA	18-4058	Dep.
463/IA,II	18-4092	Dep.
PATENTS	**(Belgian)**	
567,135	18-4144	For translation see AEC-tr-6129
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
938,364	18-3865	
940,248	18-3797	
940,254	18-4894	
940,269	18-3939	
940,425	18-4227	
940,487	18-3706	
940,572	18-4705	
940,586	18-4706	
940,685	18-4066	
940,734	18-4707	
940,743	18-4708	
940,759	18-4709	
940,790	18-4131	
940,845	18-3940	
940,856	18-4769	
940,919	18-4710	
940,940	18-4067	
941,108	18-4770	
941,125	18-3906	
941,132	18-4826	
941,310	18-4068	
941,315	18-3941	
941,403	18-3942	
941,600	18-4711	
941,668	18-4754	
941,678	18-4712	
941,806	18-4771	
941,918	18-4755	
941,919	18-4756	
941,985	18-3907	
941,986	18-3908	
942,079	18-3909	
942,157	18-4713	
942,164	18-3927	
942,277	18-4714	
942,290	18-4715	
942,308	18-4772	
942,314	18-4716	
942,319	18-4717	
942,323	18-4773	
942,411	18-4757	
942,486	18-3943	
942,954	18-3944	
943,038	18-4228	
943,118	18-4758	
943,130	18-3945	
943,453	18-3946	
943,473	18-4774	
943,496	18-4718	
943,613	18-4295	
943,657	18-4719	
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660,349	18-4148	
660,388	18-3583	
661,016	18-4721	
661,637	18-4680	
661,673	18-3866	
661,952	18-4070	
663,150	18-4776	
663,529	18-3867	
663,776	18-3910	
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669,845	18-4723	
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672,051	18-3913	
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3,113,207	18-4361	
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3,113,212	18-4137	
3,113,213	18-4075	
3,113,215	18-4050	
3,113,220	18-4076	
3,113,264	18-4077	
3,113,517	18-3929	
3,113,755	18-3950	
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3,114,682	18-3919	
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3,114,716	18-3872	
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500	18-4890	Dep.; $0.60(BIS); 3s. (HMSO)
510	18-3679	Dep.(mc); $0.60(BIS); 3s. (HMSO)
PNROO-DEV–		
124	18-4002	Dep.(mc); $1.60(fs), $0.80(mf) OTS
PPAD–		
492E	18-4368	Dep.(mc); $3.60(fs), $1.13(mf) OTS
PWA–	**(Non-AEC)**	
2279	18-4257	
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63-4109	18-4179	OTS
SC-DC–		
2049	18-4910	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3249	18-4836	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-163-6
SC-DR–		
268-63	18-4258	Dep.(mc); $2.60(fs), $0.98(mf) OTS
SC-T–		

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524	18-4935	Dep.(mc); $1.60(fs), $0.80(mf) JCL
SC-TM–		
172A-62(73)	18-4911	Dep.(mc); $7.60(fs), $2.33(mf) OTS
259-63(14)	18-4912	Dep.(mc); $1.60(fs), $0.80(mf) OTS
294-63(24)	18-4913	Dep.(mc); $2.60(fs), $1.07(mf) OTS
SEL–	**(Misc.)**	
63-103	18-4642	See TID-19771
SSD-TDR–	**(Non-AEC)**	
63-51	18-4180	$21.00(OTS)
STI-DOC–	**(International Atomic Energy Agency)**	
10/21	18-3580	Insect Population Control by the Sterile-Male Technique. Comprehensive Report of a Panel Held in Vienna, October 16–19, 1962. $1.50; Sch. 31,50; 9s. std; F.fr.6,-; DM 4,80 (IAEA)
TAM–	**(Misc.)**	
244	18-4261	See TID-19788
TID–		
4043	18-4914	Dep.; Free(DTIExtension)
7015(Suppl.5)	18-3680	Dep.; $8.00(OTS)
7683	18-3715	Dep.; $1.00(OTS)
15244(Rev.)	18-3921	$23.50(fs), $15.08(mf) OTS
15245(Rev.)	18-3922	$19.75(fs), $9.92(mf) OTS
15246(Vol.I)(Rev.)	18-3923	$23.50(fs), $14.33(mf) OTS
15246(Vol.II) (Rev.)	18-3924	$17.00(fs), $8.24(mf) OTS
15247(Rev.)	18-4215	$9.60(fs), $3.68(mf) OTS
18191	18-4369	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18282	18-3492	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18352	18-3493	Dep.(mc); $2.60(fs), $0.98(mf) OTS
18364	18-4200	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18376	18-3814	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18377	18-4916	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18382	18-4917	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18385	18-3956	Dep.(mc); $3.60(fs), $1.22(mf) OTS
18386	18-3494	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18430	18-4260	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18459	18-4370	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18605	18-3933	Dep.; $2.50(OTS)
19206	18-4138	Dep.; $2.75(OTS)
19266	18-3598	Dep.; $3.50(OTS)
19402	18-3692	J. Inorg. Nucl. Chem., 25: 1515-19(1963)
19463	18-3495	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19477	18-3957	Dep.(mc); $9.10(fs), $3.35(mf) OTS
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19736	18-3720	Dep.(mc); $2.60(fs), $1.10(mf) OTS
19738	18-4922	Dep.; $1.60(fs), $0.80(mf) OTS
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19749	18-3497	Dep.(mc); $1.10(fs), $0.80(mf) OTS
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19787	18-3499	Dep.(mc); $1.60(fs), $0.80(mf) OTS
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19789	18-4432	Dep.(mc); $8.60(fs), $3.17(mf) OTS
TIM–	**(Misc.)**	
696	18-3721	Dep.(mc)
TM–	**(Misc.)**	
62-11-15	18-4306	See TID-19501
UAC–		
7170	18-4200	See TID-18364
7178	18-4917	See TID-18382
7181	18-3956	See TID-18385
7201	18-4208	See ANL-FGF-412
7237	18-3814	See TID-18376
7251	18-3494	See TID-18386
7252	18-3493	See TID-18352
UCRL–		
6794	18-4371	Dep.; $0.50(OTS)
7167	18-3722	Dep.(mc); $11.50(fs), $4.73(mf) OTS
7335	18-4852	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-25
7353	18-4853	Dep.(mc); $3.60(fs), $1.13(mf) OTS; Gmelin, AED-CONF-63-168-26
7419	18-4060	Dep.(mc); $2.60(fs), $0.83(mf) OTS
7428	18-4181	Dep.; $1.25(OTS)
7432	18-4268	J. Am. Ceram. Soc., 46: 566(1963)
7490	18-4093	Dep.; $0.50(OTS)
7493	18-4401	Dep.; $1.00(OTS)
7513	18-4854	Dep.; $0.50(OTS)
7551	18-4413	Dep.(mc); $2.60(fs), $0.86(mf) OTS
8783(Rev.)	18-4585	Dep.(mc); $12.50(fs), $5.39(mf) OTS; Gmelin, AED-CONF-63-062-6
10215(Rev.)	18-3638	Health Phys., 9: 987-92(1963)
10700	18-4471	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10716	18-4472	$1.60(fs), $0.80(mf) OTS
10902	18-3754	J. Chem. Phys., 39: 2881-91(1963)
10973	18-4182	Dep.(mc); $2.60(fs), $0.83(mf) OTS
10977	18-4433	Dep.; $2.00(OTS)
11005	18-3500	Dep.; $1.00(OTS)
11011	18-4262	Dep.; $0.75(OTS)
11044	18-4372	Dep.; $0.50(OTS)
11076	18-4434	Dep.(mc); $1.60(fs), $0.80(mf) OTS
UCRL-Trans–		
996(L)	18-3818	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
UR–		
633	18-4925	Dep.; $1.00(OTS)
USNRDL-TR–	**(Non-AEC)**	
672	18-4027	OTS
673	18-3501	$2.60(OTS)
VDIT–	**(Swedish)**	
16(3.3)	18-4307	Dep.(mc)
WAPD–	**(Misc.)**	
276	18-4183	Dep.; $0.75(OTS)
WAPD-T–		

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1623	18-4743	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1626	18-4586	Dep.(mc); $1.10(fs), $0.80(mf) OTS
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WAPD-TM-	**(Misc.)**	
375	18-4216	Dep.; $1.00(OTS)
WCAP-	**(Misc.)**	
6057	18-4803	Dep.(mc); $2.60(fs), $1.04(mf) OTS
WP-	**(Non-AEC)**	
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WT-	**(Misc.)**	
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Y-		
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